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Journal

OF THE

University of Bombay



[HISTORY, ECONOMICS & SOCIOLOGY: NO. 7]

Vol. IV

July 1935

Part I

CONTENTS

ARTICLES

TWO UNPUBLISHED FRAGMENTARY VALABHI GRANTS	A S GADRE	1
EXCHANGE CONDITIONS IN THE JĀTAKAS	... R. N. MEHTA	10
ISLAMIC ART AND ARCHITECTURE	... ERNST COHN-WIENER	27
THE PARITY OF INDIAN COTTON	... R. G. SARAIYA	38
LIMITATIONS OF CANE SUGAR MANUFACTURE	... R. D. TIWARI	47
INDUSTRIAL FINANCE IN INDIA	... M. A. MULKY	68
THE PARSIS OF BOMBAY AND PARSI CHARITIES	... P. A. WADIA	88
GENEALOGICAL STUDY OF SOME VITAL PROBLEMS OF POPULATION [PART II]	B. L. MANKAD	105

THE UNTOUCHABLE CLASSES OF MAHARASHTRA	M. G. BHAGAT	130
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NOTES.

FIVE VALA COPPERPLATE GRANTS	...	175
------------------------------	-----	-----

<u>REVIEWS</u>	...	178
----------------	-----	-----

<u>BOOKS RECEIVED</u>	...	182
-----------------------	-----	-----

<u>ACKNOWLEDGMENTS</u>	...	184
------------------------	-----	-----

<u>EXCHANGES</u>	...	186
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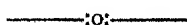
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This journal is mainly intended to promote research work by the teachers and students of the University of Bombay. It will contain original articles, abstracts of theses and reviews of books, and will be issued six times a year, the issues being devoted to the following subjects in their order:—

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Journal

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[HISTORY, ECONOMICS & SOCIOLOGY : No. 7]

VOL. IV

JULY 1935

PART I

TWO UNPUBLISHED FRAGMENTARY VALABHI GRANTS.

I. THE PITHADIA GRANT OF DHARASENA II.

This fragmentary grant, which is in reality the first half of it, was sent to me for decipherment by Mr. H. E. F. Percy, tutor and companion to a Prince at Pithadia (Jetpur, Kathiawar) in January 1934. It belongs to D. S. Mulu Vala Saheb, C. I. E. It was found lying in one of the drawers of a table, and had chalked across it the words "Remove your shoes before entering here". Evidently no one appreciated its value. Mr. Percy offered a reward for the second half which is missing, but his efforts have so far borne no fruit.

In the case of VALABHI grants it is the second half that is more important inasmuch as it furnishes important data about the donee, the property granted, the date etc. Thus the second half is historically more important. In the first half, the place from which the grant is issued and the almost stereotyped genealogy of the rulers upto the donor king are the only less important items.

This plate, which measures $10\frac{1}{4}'' \times 8''$ and contains 22 lines, is issued from Valabhi. The kings mentioned in the Genealogical Table are :—(1) Senāpati Bhaṭārka, the founder of the ruling house, and his four sons : (2) Dharasena I, (3) Droṇasimha, (4) Dhruvasena I, (5) Dharapaṭṭa ; No. 5 was succeeded by his son (6) Guhasena ; (7) Dharasena II, son of Guhasena the donor of the present grant.

Almost all the Valabhi Rulers, though staunch devotees of Śiva, were tolerant Hindu kings. Dharapaṭṭa, who is also called Dhara-

pada¹, is described in this and other grants as a devout worshipper of the "SUN" (Paramāditya-Bhakta). Śilāditya I, son of Dharasena II, though a devotee of Śiva, donated villages to Buddhist Vihāras² and granted a piece of land to a Sun Temple in the village Bhadreṇiyaka in the Bār forest.³

About 13 grants of Dharasena II are known. His earliest known grants are of 252 G. E. and the latest ones are of 270 G. E. The last known grant of his father is of 248⁴ G. E. and the 1st known grant of his successor is of 286 G.E.⁵ So it seems that Dharasena II ruled from 250 to 280 G. E. (circa).

In addition to his titles of Mahārāja and Paramamāheśvara, he uses the epithet "Sāmanta" in two grants of 252 G. E.⁶ and Mahā-Sāmanta in the grants of 269 & 270 G. E. In the present grant he bears neither of the titles—Sāmanta or Mahāsāmanta. So it is possibly later than 252 G. E. and earlier than 269 G. E. Besides the earlier grants with one exception⁷ are issued from Valabhi and the later ones are issued from victorious camps and since this grant is issued from Valabhi, it may possibly belong to the earlier part of Dharasena II's reign.

The recipients of most of Dharasena II's grants are Brahmins. The beneficiaries of three grants⁸ are Buddhist Vihāras, one of them being the Bappa Pādiya Vihāra⁹, built by Ācārya Bhadanta Sthiramati who is referred to by Hieun Tsiang.¹⁰

Though Dharasena II is invariably called Mahārāja, he styles himself as Mahārājādhirāja in the Sign-Manual at the end of the grant of 269 G.E.¹¹ which shows that he rose to higher power. The Alinā Grant of 270 G.E.¹² donates a village in the Kaira District, which

-
- (1) Journal of the Bombay Branch of the Royal Asiatic Society, New Series, Vol. I, p. 25.
 - (2) e.g., Indian Antiquary XIV, p. 327.
Journal of the University of Bombay, Vol. III, pt. I.
 - (3) Noticed in the Annual Report of Archæological Survey, Western Circle, 1919-20 ; p. 54.
 - (4) Ind. Ant. V. p. 206.
 - (5) Ind. Ant. XIV. p. 327.
 - (6) Ind. Ant. XV, 187 ; Annals of the Bhandarkar Oriental Research Institute, Vol. IV. pp. 33-37.
 - (6a) Ind. Ant. VI 9 ; J.B.B.R.A.S. N.S. I. 66.
 - (7) Sanskrit & Prakrit Inscriptions of Kathiawar. pp. 35-39.
 - (8) Ind. Ant. VI, p. 9 ; J.B.B.R.A.S. N.S. I. 66ff ; *ibid.* p. 25.
 - (9) Ind. Ant. VI 9 ff.
 - (10) *Ibid.*
 - (11) Ind. Ant. VI.
 - (12) Ind. Ant. VII. 70-71.

obviously must have formed part of the kingdom of Valabhi. In fact Dharasena II is the first Valabhi ruler who made annexations to his kingdom outside Kathiawar.

The Officers mentioned in lines 20-22 are Āyuktaka, Viniyuktaka, Drāṅgika, Mahattara, Cāṭa, Bhaṭa, Dhruvādhikaraṇika, Daṇḍapāśika, Coroddharaṇika Śaulkika, Rājasthāniya, Kumārāmātya.

Unfortunately due to the loss of the second half of the grant, information as regards the Date, the Lekhaka, the Dūtaka (the Executive Officer) etc. is lost. If our assumption that the grant belongs to the earlier period of the king's reign is true, the Dūtaka must have been Cirbira (चिर्बिर) who functions in that capacity in all the grants except those of 269 & 270 G.E. wherein Sāmanta Śīlāditya is mentioned as the Dūtaka.

The scribe is Skandabhaṭa, the Minister of Peace and War in all his grants and so must have been in the present case.

The language and the script are the same as in the other Valabhi grants. In addition to the usual points of Orthography, carelessness of the engraver is shown by (1) the presence of *visarga* where it is redundant, e.g., ll., 1, 27, (2) the absence of *visarga* where it ought to be (ll., 14, 15), (3) wrong spelling as in यथाभिलिपित (l. 8); सापर्या (l. 11); पुद्दि; आभिज्ञामिकैः (l. 17)

The plate is fairly well preserved and is at present kept in the Watson Museum of Antiquities, Rajkot.

PITHADIA GRANT OF
SRI DHARASENA II.

*Text**

1st Plate.

(१) ओं स्वस्ति वलभीतः प्रसभेः प्रणतामित्राणां मैत्रकाणामनुलबलसंपन्नमण्डला-
भोगसंसक्तसंप्रहारशतलब्ध—

(२) प्रतापः प्रतापोपनतदानमानार्जवोपार्जितानुरागोनुरक्तमौलभृतमित्रश्रेणीबला-
वासदाज्यश्रीः परम—

(३) माहेश्वरः श्रीसेनापतिभट्टार्कस्तस्य सुतस्तत्पादरजोरुणावनतपवित्रीकृतशिराः
शिरोवनतशकैचूडामणिः प्रभाविच्छुरि—

* From the original plate and the ink-impression supplied by the Government Epigraphist for India.

¶ Expressed by a symbol.

1 Drop Visarga

2 Read °राज्यश्रीः

3 Read °शत्रु°

(४) तपादनखपङ्क्तिदीधिति ईनानाथकृपणजनोपजीव्यमानविभवैः परममाहेश्वरः श्रीसेनापतिधरसेनस्तस्यानुजस्तत्पाद—

(५) प्रणामप्रशस्ततरविमलमौलिर्मणिर्मन्वादिप्रणीतविधिविधानधर्मा धर्म्मराज इव विहितविनयव्यवस्थापद्धतिरखिल—

(६) भुवनमण्डलाभोगैकस्वामिना परमस्वामिना स्वयमुपहितराज्येभिषेकमहाविश्रानावपूतराज्यश्रीः परममाहे—

(७) श्वरो महाराजा द्रोणासिंह सिंह इव तस्यानुजः स्वभुजपल्लवपराक्रमेण परगजघटानीकानामेकविजयी शर—

(८) गैषिणां शरणमवबोद्धा शास्त्रार्थतत्त्वानां कल्पतरुरिव सुहृत्प्रणयिनां रथमिलिषितकामफलोपभोगदः पर—

(९) मभागवतः श्रीमहाराज ध्रुवसेनस्तस्यानुजः तच्चरणारविन्दप्रणीतप्रविधोतो-शेषकल्मषः सुविशुद्धस्वच—

(१०) रितोदकप्रवर्षोलितसकलकलिकलङ्कः प्रसभनिर्जितारातिपक्षप्रथितमहिमा परमादित्यभक्तः श्रीमहाराजधरपट्ट

(११) स्तस्यात्मजस्तत्पादसौपर्यावाप्तपुण्योदय शैशवात्प्रभृति खैन्नद्वितीयः बाहुरेव समदपरगजघटास्फोट—

(१२) न प्रकौशनसत्वनिकषस्तत्प्रभावप्रणतारातिचूडारत्नप्रभासंसक्तसंव्येपादनखरश्मिसंयेतिः" सकलस्मृतिप्रणीतमा—

(१३) र्गसम्यक्परिपालेनाप्रजाहृदयरञ्जनादन्वर्थराजशब्दो रूपकान्तिः स्थैर्य-गाम्भीर्ययुद्धिसम्पद्भिः स्मरशशाङ्कादि—

(१४) राजोदधिन्निदशगुर्जधनानतिशयानः शरणागताभयप्रदानपरतया तृणवदपास्ताशेषस्वकार्यफलं प्रार्थ—

(१५) नाधिकार्थप्रदानानन्दितविद्वत्सुहृत्प्रणयिहृदयैः पादचारीव सकलभुवनमण्डलाभोगप्रमोदः परममाहेश्वर

(१६) श्रीमहाराजगुहसेनस्तस्य सुतस्तत्पादनखमयूखसन्ताननिर्वृत्तैर्जाह्नवीजङ्गी-घविक्षालिताशेषकाल्मषः प्रणयि [शत]

4 Read °मौलिमणि°

6 Read °द्रोणासिंहः

8 Read यथाभिलषित°

10 Read °प्रक्षालित°

12 Read °पुण्योदयः

14 Read °प्रकाशित°

16 Read °संहतिः

18 Drop visarga.

20 Read °गुरुधनेशा°

22 Read हृदयः

24 Read °जलौष°

5 Read °राज्याभिषेको

7 Read स्वभुजबल°

9 Read °प्रविधौता°

11 Read °सपर्या°

13 Read °द्वितीयबाहुरेव

15 Read °सव्य°

17 Read °पालन°

19 Read °बुद्धि°

21 Read °फलः

23 The usual reading is °निसृत°

(१७) 'सहस्रोपजीव्यभोगसंपत्तौ रूपलोभादिवाञ्छितः सरभसमाभिङ्गामिकैर्गुणैस्सह जशक्तिशिक्षाविशेषविस्मापिताखिल—

(१८) धनुर्द्धरः प्रथमनरैपतिः समतिसृष्टानामनुपालयिता धर्मदायदानामि-
पाकर्त्ता प्रजोपघातकारिणामाबद्धो—

(१९) रानों दर्शयिता श्रीसरस्वत्योरेकाधिवसंस्य संघतौरातिपक्षक्षमीपरिक्षोभै-
दक्षविक्रमक्रमोपसंप्राप्तविम—

(२०) लपार्थिवैः परममाहेश्वरो महाराजश्रीधरसेन)(कुशली सर्वानेवायुक्तकवि-
नियुक्तद्राक्षिक

(२१) महत्तरचाटभटध्रुवाधिरणिकदाण्डपाशिकचौरोद्धरणिकशौलिकराजस्था—

(२२) नीयकुमारामात्यादीनौन्यांश्च यथै सम्बध्यमानकान्समाज्ञायत्यस्तु वः

II. THE UNDAVI PLATE ŚĪLĀDITYA IV (or V?).

This Plate was found in a field called Talaviya, in the village Unḍavi, belonging to the Vala State, but situated under the jurisdiction of Gogha-Ahmedabad Collectorate. A farmer was working in a field when his plough brought it out to light. Mr. R. L. Mehta, the ex-Karbhari of Vala State, sent it to me for decipherment in September, 1931, for which I am very much obliged to him.

The plate is only the first half of the grant and is inscribed on one side only. It measures $14\frac{1}{2}'' \times 11''$. The edges are just slightly raised in order to protect the writing, which is fairly well preserved. The letters, which are deeply incised, show through on the other side of the plate. As is hardly found in any other case, this plate has strangely enough two pairs of holes—one near each of the two upper lengthwise edges. Usually in the case of Valabhi grants, there is a pair of holes near the lower edge of the 1st plate and the upper one of 2nd half, intended to receive the seal and the ring. It is probably through mistake that the two holes are bored near the upper lengthwise edge of this plate. It contains 29 lines. A detailed description of the *characters, language, orthography, etc.*, which is the same as in other Valabhi grants, would be superfluous.

The plate is issued from the victorious camp at *Sāvandika*. This plate, which is the first half, ends with the words, "*Parama-māheśvaraḥ Paramabhaṭṭāraka-Mahārājādhirāja-Parameśvara-Cakra-*

25 Read °संपद्भूप°

27 Read °नरपतिसमति°

29 Read °कारिणामुपप्लवानां

31 Read संहता°

33 Read °पार्थिवश्रीः

35 °दीनन्यांश्च

37 Read समाज्ञापय°

26 Read °भिगामि°

28 Read धर्मदायानामपाकर्णं

30 Read °धिवासस्य

32 a variant is परिभोग for परिक्षोभ

34 Read °चोरोद्धरणिक°

36 Read यथा

vatī Śrī Dharasenah." It¹ was wrongly described by me as a grant of Dharasena IV. I have since revised my views and have come to the conclusion that it must have belonged to Śilāditya IV (or V). For the number of lines in the Plate and its size almost correspond with these details of the known grants of these two kings.

Genealogy :—As usual the genealogical table starts with Bhaṭārka, the founder of the dynasty. In order to curtail *details* and restrict the matter to two plates only, Śilāditya I, started the practice of omitting four kings after Bhaṭārka, who were his sons. The Kings mentioned here are (1) Bhaṭārka, (2) his grand-son Guhasena, (3) Dharasena II, son of Guhasena, (4) Śilāditya I, elder son of Dharasena II, (5) Kharagraha I, younger brother of Śilāditya I, (6) Dharasena III, elder son of Kharagraha I, (7) Dhruvasena II, younger brother of Dharasena III, (8) Dharasena IV, son of Dhruvasena III. This last king is mentioned in the last line of this plate. If my guess is true, this plate belongs to Śilāditya IV or V and in the second half which is missing we get account of the successors of Śilāditya I. The direct line of Kharagraha I, who seems to have succeeded to the throne with force, came to an end with Dharasena IV and the throne passed again to the heirs of Śilāditya I. An account of the successors of Dharasena IV can be had from the grants of the 375 and 403 G. E.² After Dharasena IV, mention³ is made of Derabhaṭa, son of Śilāditya I, who is described as a royal sage and a petty chieftain. (9) Dhruvasena III, the youngest son of Derabhaṭa, succeeded by force to the throne, after Dharasena IV. (10) Dhruvasena III, was succeeded by his elder brother, *Kharagraha II*, whom he had superseded. (11) Kharagraha II, was succeeded by Śilāditya III, who was the son of Śilāditya II, the eldest brother of Kharagraha II. Śilāditya II, like his father Derabhaṭa, does not seem to have been a king of Valabhi. After Śilāditya III, we get (12) Śilāditya IV, and (13) Śilāditya V.

In this plate in line 12 Kharagraha I. is described as the son of Śilāditya I (तस्य सुतः) which is obviously wrong as seen from other grants. The same mistake occurs in the grants of Śilāditya V, and hence *this* plate might belong to Śilāditya V.

It is not possible to guess the Dūtaka and the Lekhaka of this grant for in the first place we do not know whose it is and secondly, we are ignorant of its date.

The plate is at present preserved in the State Museum at Vala.

1. See Annual Report of the Watson Museum, for 1931-32, p. 6.

2. Bhavnagar Prakrit and Sanskrit Inscriptions, p. 44 ; J. B. B. R. A. S., Vol. XI, p. 335.

3. *Ibid.*

Fragmentary Copperplate Grant of the Valabhi King Śilāditya IV (?)

The Unḍvi Plate.

Text*.

(१) [अ] स्वस्ति विजयस्कन्धावारा[त]सावण्डिकवसेका[त]प्रसभप्रणतामित्राणां
मैत्रकाणामतुलबलसंपनमण्डलाभोगसंसक्तप्रहारशतलब्धप्रतापा [त] प्रतापोपनतदानमाज्ज्वो-
पार्जितानुरा [गा]

(२) [द] नुरक्तमौलभृतश्रेणीबलावाप्तराज्यश्रियः परममाहेश्वरश्रीभट्टार्कादव्यवच्छि-
नंराजवंशो मातापितृचरणारविन्दप्रणतिप्रविधौताशेषकल्मषः शैशवात्प्रभृति खल्व—

(३) द्वितीयबाहुरेव समदगजघटास्कट्टनप्रकाशितसत्त्वनिकषः तत्प्रतापप्रणतारति-
चूडारत्नप्रभासंसक्तपादनखरश्मिसंहतिसंकलस्त्रिप्रणीतमा—

(४) र्गसम्यक्प्रैतपालनप्रजाहृदयरंजना[द]न्वर्थराजशब्दोः रूपकान्तिधैर्य्यगाम्भीर्य्यं
बुद्धिसंपद्भिः स्मरशशाङ्काद्रिराजोदधित्रिदशगुरुधनेशन—

(५) तिशजोनः शरणागताभयप्रदानपरतया तृणवृद्धपास्ताशेक्षैस्वकार्य्यफलैर्प्राथ-
नाधिकार्थप्रदानानन्दितविद्वत्सुहृत्प्रणयिहृदयः पादचौरीः

(६) सकलभुवनमण्डलाभोगप्रमोदः परममाहेश्वरः श्रीगुहसेनस्तस्यसुतस्तत्पादन-
खमयूखसन्तानविसृतिजिह्वाजीजलौघप्रक्षालिताशेषकैल्मष प्रण—

(७) यिशतसहस्रोपजीव्यमानसंपदूपलोभादिवाश्रितः सरभसमाभिगामिकैर्गुणैः सह-
जशक्तिशिक्षाविशेषविस्मापिताखिलधनुर्द्धरः प्रथमनरपतिसमतिमृष्टा—

(८) नामनुपालयिता धर्मदायानामपहर्ता प्रजोपघातकारिणामुपद्रवाणां दर्शयित
श्रीसरस्वत्योरेकाधिवासस्य संहतारातिपक्षलक्ष्मीपरिभोगदक्षविक्रमो

(९) विक्कमैभौघप्राप्तविजयपार्थिवश्रीः परममाहेश्वरः श्रीधरसेनस्तस्य सुतस्तत्पादा-
नुध्यातः सकलजैनानन्दनात्यद्भुतगुणसमुदयस्थगितसमप्रमण्डलैः समरशतविज—

(१०) यशोभासनाथमण्डलाप्रयुतिर्भासुरैरतारान्सेपीठेव्यूढगुरुमनोरथमहाभारः सर्व-
विद्यापरापरविभागाधिगमविमलमतिरपि सर्वतः सुभाषितलवेनापि सुखो—

(११) पपादनीयपरितोषः समग्रलोकागाधगाम्भीर्य्यहृदयोपि सुचरितातिशयसुव्यक्त-
प[र]मकल्याणस्वभावः खिलीभूतकृतयुगनृपतिबलविशोधनाधिगतोदप्रकीर्तिर्द्धर्मानु [प]—

* From the original plate and a photograph.

- | | |
|---|--|
| 1 Read ^० वासकात् | 2 Read न्यवच्छिन्न |
| 3 Read ^० स्फोटन ^० | 4 Read संहतिः |
| 5 Read ^० स्मृति ^० | 6 Read ^० प्रतिपालन |
| 7 Read रंजन | 8 Drop visarga after ^० दो |
| 9 Read ^० शयानः | 10 Read ^० शेष ^० |
| 11 Read ^० कार्य्यफलः | 12 Read ^० चारीव |
| 13 Read विसृत | 14 Read ^० कल्मषः |
| 15 Read संहत ^० | 16 विक्रमोपसंप्राप्त in grant of Sam 375 |
| 17 सकलजगदानन्द ^० in some grants | 18 Read दिङ्मण्डलः |
| 19 Read ^० द्युतिभासुर ^० | 20 Read ^० रांस ^० |

(१२) रोधोज्वलतरीकृतात्थमुखसंपदुपसेवानिरूढधर्मादित्यद्वितीयनामा परम-
माहेश्वरः श्रीशीलादित्यस्तस्य सुतस्तत्पादानुष्यातः स्वयमुपेन्द्रगुरुणेव गुरुणात्यादरव [ता]

(१३) समभिलषणीयामपि राजलक्ष्मीं स्कन्धासक्तौ परमभद्रं इव धुर्यस्त [दाहा]
संपादनैकरसतयैवोद्गहं खेदमुखरतिभ्यामनायासितसत्त्वसंपत्तिः प्रभावसंपद्वशी [कृत]

(१४) नृपतिंशतशिरोरत्नच्छायोपगूढपादपीठोपि परावज्ञाभिःमौनसाहसानालिङ्गित-
मनोवृत्तिः प्रणतिमेकां परित्यज्य प्रख्यातपौरुषाभिमानैरप्यरातिभिरना [सा] -

(१५) दीर्घप्रतिक्रियोपायः कृतनिखिलभुवनमोदविमलगुणसंहतिः प्रसभविघटित-
सकलकलविलसितगतिरतिनीचजनावगाहिभिर्दोषैरैशैरनामृष्टाल्युन्नतहृदयः प्रख्यातपौरुषा-

(१६) ह्यकौशलतिशयगणतिथविपक्षक्षितिपतिलक्ष्मीस्वयंप्रैहःप्रकाशितवीरपुरुषप्रथम
संख्याधिगमः परममाहेश्वरः श्रीखरग्रहस्तस्य सुतत्पादानुष्यातः सर्वविद्या-

• (१७) धिगमविहितनिखिलविद्वज्जनमनपरितोषातिशयसैत्वसंपदा त्यागौदार्येण च
विगतानुसंधानैः समाहितारातिपक्षमनोरथरथक्षेपभंगः सम्य-

(१८) गुपलक्षितानेकशास्त्रकलालोकचरितगह्वरविभागोपिपरमभ [द्र] प्रकृतिरपरिहृ-
तृमप्रश्रयोपि विनयशोभविभूषणः समरशतजयपता-

(१९) काहरणप्रत्यलोदप्रैबाहुदण्डविध्वंसैतनिखिलप्रतिपक्षदम्पोदयः स्वधनुप्रभावं-
परिभूतास्त्रकशलाभिर्मौनः सकलनृपतिमण्डलाभिनन्दित-

(२०) ईषानः परममाहेश्वरः श्रीधरसेनस्तस्यानुजैः तत्पादानुष्यातः सुचरिताति-
शयितसकलपूर्वनरपतिरतिदुस्साधनानां साधयिता विषयै-

(२१) णां मूर्तिमानिव पुरुषकारः परिवृद्धगुणानुरागनिर्भरचित्तवृत्तिर्मनुरिव स्वमभ्युप-
पन्नप्रकृतिभिरधिगतकलाकलापः कान्तिमात्रैव-

(२२) तिहर्तुरेकलङ्कः कुमुदनाथः प्राज्यप्रतापस्थगितदिगन्तरालः प्रध्वंसितध्वान्त-
राशि सैततोदितःस्ववित्तौ प्रकृतिभ्यः परंप्रत्ययमर्त्यवन्तमति-

(२३) बहुतिथप्रयोजनानुबन्धमागमपूर्णं विदधानः सन्निविप्रहसमासनिश्चयनिपुणं
स्थानानुरूपमादेशं ददद्गुणवृद्धिवि-

21 Read राजलक्ष्मीं स्कन्धासक्तौ

23 Read भिमान

25 Read संहतिः

27 Read स्वयंग्रहप्रकाशित

29 Read मनःपरि

31 Read संधानसमा

33 Read व्यकृत्रिम

35 विध्वंसित

37 Read कौशल

39 Read नुजस्त

41 Read निवृत्ति

43 Read प्रध्वंसित

45 Read सविता

22 वोद्गहन्

24 Read दित

26 Read दोषैरैशै

28 Read सुतस्तत्पा

30 षातिशयः

32 Read रथाक्षभंगः

34 Read प्रत्ययो

36 Read स्वधनुःप्रभाव

38 Read भिमानसकल

40 Read विषयाणां

42 हेतु

44 Read राशिः

46 Read निपुणः

(२४) ध्वनजनितसंस्कारस्साधूनां राज्यसौलतुरीयतन्त्रयोरुभयोरपि निष्णातः प्रकृ-
ष्टविक्रमोपि करुणामृदुहृदयः श्रुतवानप्यगर्वितः

(२५) कान्तोपि प्रशमी स्थिरसौहार्दोपि निरसिता दोषवतामुद्दयसमयसमुपजनित-
जनानुरागः परिविहितभुवनसमर्थितप्रथित—

(२६) बालादित्यद्वितीयनामा परममाहेश्वरः श्रीध्रुवसेनस्तस्य सुतस्तत्पाद-
कमलप्रणामधरणिकषणजनितकिणलान्नललाटचन्द्रशक—

(२७) लः शिशुभाव एव भ्रवणनिहितमौक्तिकालंकारविभ्रमामलश्रुतिविशेषः प्रदा-
नसलिलक्षालिताप्रहृष्टारविन्द [:]

(२८) कन्याया इव मृदुकरप्रहणादम [न्दी] कृतानन्दविधिः^{४७} र्वसुन्धरायाः काम्मुको
धनुंवेव इव संभावितांशेषलक्षकलप—

(२९) प्रणतसामन्तमण्डलोत्तमातङ्गभृतचूडारत्नायमानशासनः परममाहेश्वरः परम-
भट्टारकमहाराजाधिराजपरमेश्वरचक्रवर्ति श्रीधरसेनः॥

A. S. GADRE.

47 Read राज्यसौलतुरीय^०

49 Read ^०विधि

48 Read ^०नुरागपरिपिहित^०

50 Read ^०कलपः

EXCHANGE CONDITIONS IN THE JĀTAKAS

“ Merchants through hope seek treasures far and wide,
And taking ship on ocean's billows ride ;
There sometimes do they sink to rise no more
Or else escaping, their lost wealth deplore ”

—*Sudhābhajana Jātaka*¹.

“ The ocean ever ebbs away.
And fills again the self-same day ”

—*Samudda Jātaka*².

The *Jātakas*—a collection of stories that had their origin among the simple folk of Ancient India—present us with a vivid picture of the life in the dim distant past, of a period which may here be called the Pre-Buddhistic. To do full justice to all the aspects of human life within the scope of such a short article as this, would, of course, be impossible. Hence we have concerned ourselves with only one aspect of human life : the economic life in Pre-Buddhistic India, and that too, mainly with the conditions of exchange. This, we hope, will not be without some interest to lovers of Ancient Indian History.

It is indeed surprising to note in the *Jātakas* that, even in those days of the remote past, brisk trade was being carried on—by land as well as by sea. The inland trade seems to have been extensive. It was important in itself and also served as a feeder to the sea-borne trade. Benares was indeed the chief industrial and commercial centre in those days. From it passed the great routes to and from all directions on land and water.

I.—INLAND TRADE

From east to west (*pubbantā aparāntam*)³ is of course a general term for the great trade route that passed through different stages.

1. *Jātaka*, V. p. 401. *Gāthā*, 244. The oversea trade between India and the neighbouring countries existed from very early times, even before the time of the *Vedas* which contain numerous references to it. See *Vedic Index*, I. p. 462 ; II pp. 431-3. See also P. T. Shrinivas Aiyangar, *Trade in India* (*Indian Historical Quarterly*, I. pp. 693 ff.; II. pp. 38 ff.)
2. *Jātaka*, II. p. 442. *Gāthā*, 138.
3. J. I. pp. 98, 368, III. p. 502 ; V. p. 471.

Taking Benāres as the centre of this route we can trace out the different stages through which the traffic was carried on. Leaving out Tāmā-litti on the extreme east coast which was undoubtedly a great port¹, but which does not appear in the stories, we see that Campā was the next great trading centre from the east. We know that traders from there sailed to Suvāṇṇabhūmī², probably passing through Tāmā-litti. On land, Campā was joined with Mithilā, the Videhan capital³. But further west, along the river came the great centre Benāres⁴. On land Benāres had busy trade relations with Ujjenī⁵. The route, probably passed through Kosambī and the Cetī country, as we have mention at least of a highway from Benāres to Ceṭī.⁶ On this side the route branched off to Rājagaha⁷. From Videha to Gandhāra was a very brisk traffic⁸. It was largely by river, and must have passed through Benāres. To reach Kampilla or further still to Inḍapatta from Mithilā⁹, one must have had to follow up this route upto Prayāga, and then sail up the river Ganges, while the Yamunā might carry him up to Madhurā. Further westward the journey would again be overland to Sindha, whence came large imports in horses and asses¹⁰, and to Sovīra and its ports. Northward (*uttarāpatha*) lay the great trade route connecting India with Central and Western Asia,

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1. Cf. Law, *Geography of Early Buddhism*, p. 69. The branch of the celebrated Bodhi-tree was taken from this port to Ceylon.
 2. J. VI. pp. 34 ff.
 3. J. VI. p. 32. The distance between the two is said to have been 60 leagues (*yojana*).
 4. The defaulting wood-wrights of the *Samuddavāṇija Jātaka*, J. IV. p. 159, reach an ocean island from Benāres. From here also Sankha, the Brāhmaṇa goes to Suvāṇṇabhūmi, IV. p. 15. Pātali-putta (Patna), coming between Campā and Benāres, is not mentioned in the stories. It was perhaps a very small village as testified to by Buddha himself. See *Digha Nikāya*, II. 86. The celebrated Visākhā journeyed from Campā to Śrāvastī by boat—*Tibetan Tales*, pp. 115-6.
 5. J. II. p. 248.
 6. J. I. pp. 253-4. Probably this route from Benāres to Ujjenī met at Kosambī the great 'North to South-west Road' from Sāvattī to Patitṭhāna, given in the *Sutta Nipāta*, verses 1011-3; Sāvattī, Sāketa, Kosambī, Vedisā Gonaddhā, Ujjenī, Māhissati and Patitṭhāna. See *Buddhist India*, p. 1103. From Ujjenī, to Rājagaha the way lay through Kosambī—*Mahāvagga*, VIII. 1, 27. From Māhissati to Bharukaccha was an easy way along the Narmadā.
 7. J. I. p. 466.
 8. J. III. p. 365.
 9. J. VI. p. 447.
 10. J. I. pp. 124, 178, 181; II. pp. 31, 287; V. pp. 259-60; VI. p. 265.

by way of Taxila (Takkasilā) in Gandhāra near Rāwālpindi and presumably also of Sāgala in the Punjab¹. Now this was the route which passed through the great desert (Marukāntāra)—60 leagues wide²—probably the sandy desert of Rājaputānā of which we read often. Caravans crossed this desert day in and day out. "The tradesman," says Fick³, "who goes about in the country with his caravan is in fact a typical figure in our narratives and according to the statements in these, caravan traffic cannot have been small, either with regard to the distance traversed or with regard to the wares carried." Thus we see that big trade routes, through rivers and deserts, crossed the land in all directions and carried on an exchange of goods (bhaṇḍam) between the several and widely different parts of India.

• So much for the inland trade.

As regards the riverine traffic and the sea-borne trade also, we have some notices. "The plentifulness of great navigable waterways in Northern India allows us to assume an early development of maritime trade."⁴ Well-known sea-ports like Bharukaccha (Broach)⁵, and the sea-board of Sovira⁶, on the west, and Kavīrapaṭṭana⁷, and the less-known ones like Karambiya⁸, Gambhīra⁹, and Seriva¹⁰ on the south and east are mentioned. Suppāraka might also be added to the list¹¹. The great rivers served as commercial routes and royal roads

1. *Cambridge History of India* : I. p. 214. We cannot say by which route the 100 league distance between Sāgala and Kusāvati, if this be true, was traversed by Kusa, J. V. p. 290.
2. J. I. pp. 99, 108. (*Satthiyojanakam marukāntāram*).
3. *Social Organisation*, p. 272. According to the *Tibetan Tales*, p. 99. Jivaka's journey from Takkasilā to Rājagaha lay through Bhadrakara city, Udumbara city, Rohitaka land, Mathurā city, Yamunā river and Vaisālī, corresponding more or less to the outline drawn above.
4. Fick, *op. cit.*, p. 270.
5. J. III. pp. 126-7, 188, 190. G. 57 ; IV. pp. 137-42.
6. J. III. p. 470.
7. J. IV. p. 238. See Kanakasabhai, *The Tamils 1800 years ago*, quoted by Subbarao, *Economic and Political Conditions*, p. 81, ff.
8. J. V. p. 75.
9. J. I. p. 239.
10. J. I. p. 111. It is presumed that this Seriva is identical with the Seriyāpuṭa mentioned in a votive table on the *Bharhut Stupa*. See Barua, *Bharhut Inscriptions*, pp. 32, 130.
11. J. IV. pp. 138-42. Other references to unnamed Paṭṭanagāmas or sea-port towns are : J. II. p. 103 ; IV. p. 16.

connected the important cities. Thus it was practicable to reach any of these ports from inland towns like Campā and even Benares, as we have seen. A brisk coastal trade must also have been maintained between the sea-port towns themselves.¹

2.—SEA-BORNE TRADE

And as to the seafaring activities of the people of that age there cannot be even the shadow of a doubt.² We have ample references, however meagre the details may be, to show that brisk trade was carried on between India and the neighbouring countries, on the west and the east.

In the *Valāhassa Jātaka*³, which reminds us of the sirens and other akin creatures, we are told the fate of five hundred ship-wrecked traders, who fall in the hands of she-goblins (*yakkhinis*) in Tambappaṇṇi or Ceylon. Again in the *Sankha Jātaka*⁴, we have a figure of a ship-wrecked man on a voyage from Benares to Suvannabhūmi or Lower Burma in search of wealth. In the *Sīlanisāmsa Jātaka*⁵, we see a sea-faring nymph as helmsman bringing ship-wrecked people from off the sea to Benares by river."

Similarly, we hear, in the *Mahājanaka Jātaka*⁶, of merchants who sailed from Campā bound for Suvannabhūmi, the great trading centre to which traders even from Bharukaccha⁷ went, doubtless putting in at a Ceylon (Tambappaṇṇi) port : for Ceylon was another bourne of oversea commerce, and one associated with ports around which Odyssean legends have grown up."⁸ The now well-known *Bāveru-Jātaka*⁹, undoubtedly points out to the existence of commercial inter-

1. Cf. "The whole of the sea-board from Broach to Cape Comorin was studded with marts and emporia that served as warehouses for the products of the whole of India and poured from their ample stores commodities of various kinds into the markets of the west." P. V. Kane, in *Proceedings, I. Oriental Conference*, Poona, II. p. 365. The '*Periplus*' bears ample testimony to this.

2. See Kennedy, *The Early Commerce of India with Babylon*, (700-300 B.C.), *J. R. A. S.*, 1898, pp. 241-88 ; Scoff, *The Periplus*, pp. 228, ff. Fick, also doubts trading on the high seas, *op. cit.*, p. 269.

3. J. II. pp. 127 ff.

4. J. IV. pp. 15-7.

5. J. II. pp. 112-4.

6. J. VI. p. 34.

7. J. III. p. 188.

8. *C. H. I.*, p. 213.

9. J. III. p. 126 ff. On this Jātaka, see Bühler, *Origin of the Indian Alphabet*, p. 84.

course between India and Babylon through the Persiap Gulf. But the most important of all these is the *Suppāraka Jātaka*¹, which records though in the usual mystic manner, the perilous adventures on the high seas undergone by a company of traders who sailed from the sea-port town of Bharukaccha, in a vessel under the pilotage of a blind but accomplished mariner. The story gives the names of some of the seapoints through which the traders passed. They were in succession as follows :

(a) Khuramāla, (b) Aggimāla, (c) Dadhimāla, (d) Nilakusamāla, (e) Nalamāla, and (f) Valabhāmukha. Now from the names and the description given in the *gāthās*, it has been possible to identify these spots respectively with (a) some portion of the Persian Gulf, perhaps touching the south-eastern end of Arabia ; (b) the Arabian coast near Aden or some portion of the Somali-land ; (c) the Red Sea ; (d) Nubia on the N.-E. corner of Africa ; (e) the canal joining the Red Sea with the Mediterranean ; and (f) the volcano-sea, i.e., some portion of the Mediterranean Sea where volcanoes are still to be seen². Thus it shows the whole sea-route from Broach up to the Mediterranean, passing through the Persian, Arabian and the Red Seas. The trade-relations of India with Babylon, Arabia, Egypt, Greece and South European countries on the Mediterranean are, thus, undeniable.³

What commodities were exported and imported⁴, or what exchanged inland we do not clearly know. Of the inland trade we are mostly told of five-hundred waggons laden with valuable goods. Probably these loads (bhaṇḍam) contained cloths for which Benares was so famous. Once⁵ we read of rice, beans and other grains dropped by passing waggons. But, as pointed out by Subbarao⁶, food-stuffs could hardly have entered into the trade between distant places in those days. The silken robes of Kāsī,⁷ the woollen rugs of Gandhāra,⁸ and the linen cloths of Koḍumbara (in the Punjab),⁹ must have been

1. J. IV. pp. 138-42. GG. 105-115.

2. See Jayaswal, *J. B. O. R. S.*, VI. p. 195.

3. See Mookerji, *Indian Shipping*, pp. 82 ff.

4. On this and generally on the whole chapter, it would be worth-while comparing Prof. Lassen's valuable treatise on the *History of Indian Commerce* ; translated in *J. B. O. R. S.*, X. pp. 229-316.

5. J. I. p. 429.

6. *Op. cit.*, p. 80.

7. J. II. p. 443, G. 141 ; III. p. 10 ; p. 78, G. 230 ; VI. pp. 49, G. 192 ; 50-G. 225.

8. J. VI. p. 500, G. 1796.

9. *Ibid.* G. 1891.

some of the exchangeable commodities. The needle-work and steel-work of Dasāṇṇa, or the late Vidiśā (Bhilsa region in the C. P.), was sufficiently famous to be distributed¹. Peacocks and birds must have been included.² In general, "silks, muslins, the finer sorts of cloth and cutlery and armour, brocades, embroideries and rugs, perfumes and drugs, ivory and ivory work, jewellery and gold," were no doubt "the main articles which the merchants dealt in."³

3.—TRANSPORT

It is essential for the growth of trade and commerce especially, that there should be fairly developed means of rapid and cheap communication or transport. Of course, in those early days we cannot expect much more than carts drawn by animals on land, simple boats on rivers and well-constructed ships on the sea.

We find numerous references to roads⁴, but it is not clear what sort of roads they were. Prof. Rhys Davids says: "There were no made roads and no bridges. The carts struggled along, slowly, through the forests, along the tracks from village to village kept open by the peasants. The pace never exceeded two miles an hour. The smaller streams were crossed by gullies leading down to fords, the larger ones by cart ferries."⁵ Probably, things were not quite so primitive. Mention of "highways" and royal roads (*mahāmagga* : *mahāpatha* : *rājamagga*) as distinguished from bye-lanes and bye-roads (*upa-patha*)⁶ might suggest the existence of well-constructed roads. Still, however, the conditions do not appear to have been satisfactory. Roads were not smooth⁷. They lay through forests and deserts and beset with many dangers from draught, famine, wild beasts, robbers, demons, poisonous trees and so on.⁸ The travellers, often experienced want of water⁹ though wells were dug by the road-

1. J. III. pp. 282 ff. p. 337 ff. G. 39.

2. J. III. pp. 126 ff. Cf. *The Bible*, Kings, X 22.

3. Cf. Rhys Davids, *Buddhist India*, pp. 98 ff.; Cf. Mookerji, *Indian Shipping*, pp. 82 ff. Lassen's *History* loc. cit.

4. J. I. pp. 98, 99, 100, 128, 225 ; II. pp. 3, 70, 82, 118 ; III. pp. 200, 526 ; V. pp. 22, 46, 226, G. 81 ; VI. pp. 137, 341, 348, 380.

5. *Buddhist India*, p. 98.

6. J. I. p. 351 ; II. pp. 3, 70, 303, III. p. 49, V. pp. 106, 286, G. 81 ; VI. pp. 51, 179.

7. J. I. p. 194.

8. J. I. pp. 98, 271, 274, 283 ; II. pp. 335 ; IV. p. 185 ; V. pp. 22, 471. The *Chhaddata Jātaka*, J. V. p. 46, gives a graphic description of roads that lay through jungles and other kinds of tracts.

9. J. I. 99, 109.

side¹. The journey of a caravan through desert or forest country is indeed a typical feature of our stories. The *Apaṇṇaka*², and the *Vaṇṇupatha*³ *Jātakas* throw a flood of light on the difficult way in which trade was carried on by these caravans. We are told of five kinds of wildernesses (*kantāras*); those infested with robbers, those in which wild beasts abounded; those others visited by drought, demons and famine. They were, in reality, probably⁴ the five successive portions of the route over the deserts of Rājaputānā.

"Whenever the wind blows in their teeth they ride on in front in their carriage with their attendants round them, in order to escape the dust, but when the wind blows from behind them, they ride in like fashion in the rear of the column." If it was a forest or a shaded or cool tract, the travellers kept on their march all the day long, and at sunset they unyoked their carts and made a laager, tethering the oxen to the wheels. The oxen were made to lie down in the middle with the men round them. The leader of the caravan with the leading men of his band had to guard at night. At day-break, again, the caravan started on its march⁵. If the portion of the route was an empty desert, they had to travel by night. The sand of the desert grew as hot as a bed of charcoal embers, at day time, and nobody could walk upon it. So they used to take firewood, water, oil, rice and so forth on their carts, and only travelled by night⁶. At dawn they used to range their carts in a circle to form a laager, with an awning spread overhead, and after an early meal used to sit in the shade all day long. When the sun went down, they had their evening meal; and as soon as the ground became cool, they used to yoke their carts and move forward. Travelling on this desert was like voyaging over the sea: a desert-pilot (*thalaniyyāma*) had to convey them over by knowledge of the stars.⁷

And the way was often insecure. Organised bands of robbers, with shields on their shoulders and swords in hands, lay in wait for these tradesmen⁸ especially in the forest. And there were forest-

1. J. II. p. 70.

2. J. I. pp. 99 ff.

3. *Ibid.* pp. 107 ff.

4. *Barua, Proceedings, 4th Oriental Conference*, II. p. 213.

5. J. I. p. 101 ff.

6. Cf. Pliny's account of the journey on desert on the Red Sea border : (VI. 26) : Schoff, *Periplus*, p. 232-3.

7. J. I. pp. 107 ff.

8. J. IV. p. 185-G 58; Cf. I. p. 283; II. p. 335; V. pp. 22, 422.

people (*aṭavimukhavāsi*) at the entrance who led the caravans through the dangerous places and were paid for¹.

Indeed, the way was wearisome and the progress slow. The carts were drawn by oxen and the broad rims of their wheels were protected by iron bands². These carts or waggons were the ordinary *Sakaṭas*³. But there were cars of richer style, no doubt. The *ratha* or the *sukhayānaka* was drawn by horses. It had comfortable seats⁴. Litters or *Sivikās* were used by the royalty and the wealthy⁵.

The great rivers did, no doubt, furnish means of communication and some facilities of transport. Of bridges we have no mention⁶. There were fording places⁷, and the streams and water courses were crossed by means of boats⁸. There were canoes (*dāruphalakāni*) also⁹. People made a living by conveying people and goods across the rivers¹⁰.

The maritime transport appears to have been greatly developed, though not devoid of its own dangers. As already noticed, sea navigation was common. Voyages were mostly undertaken for purposes of trade by companies of merchants,¹¹ though passengers were also taken up.¹² The ships were built of wooden-planks (*dāruphalakāni*),¹³ and were dependent on wind (*erakavāṭayuttā*) for their onward journey.¹⁴ Ship-building was fairly advanced, as we have seen.¹⁵ As to the construction of the ships we are told that besides the outer frame-work, there used to be three masts (*Kūpā*, mod. *Kuvāthamba*), cordage (*yottam*), sails (*sitam*), planks (*padarāni*),

1. J. V. pp. 22, 471.
2. J. IV. p. 210.
3. J. IV. pp. 207-8, 458.
4. J. I. pp. 175, 202 ; II. p. 339 ; III. p. 527 ; IV. p. 207-8, 458 ; V. p. 164.
5. J. IV. p. 378 ; VI. p. 500-G. 1797 ; 514-G. 1913.
6. But there was something like a causeway (*setu*) or raised dyke built over shoals : C. H. I., I. p. 214.
7. J. III. p. 230.
8. J. II. p. 423 ; III. p. 230 ; IV. p. 234, 478.
9. J. IV. p. 456 ; V. p. 163 ; VI. p. 305 ; Cf. *Dhoni*.
10. J. I. p. 112 ; III. p. 188.
11. J. II. p. 129 ; IV. p. 142 ; V. p. 75.
12. J. II. p. 111 ; III. p. 188.
13. J. II. p. 111 ; IV. p. 20-G. 32 ; VI. pp. 34, 427.
14. J. I. p. 239 ; II. p. 112 ; IV. p. 20-G. 32.
15. J. IV. p. 159 ; VI. p. 427.

the oars and rudders (*phiyāritāni*) and anchors (*lankgrao*).¹ The pilot on board (*niyyamaka*) had the charge of the rudder and guided the ship.²

But there were serious dangers on the high seas. Does not the poor mother in one of our *Jātakas* say to her son who is bent upon sailing to a far-off country, that "the sea has many dangers"?³ Out stories are full of ship-wrecks, indeed. Sometimes the ship may be swallowed away by whirlpools (*vohara*).⁴ But often the timber could not withstand the terrible force of the surging waves. There was a leakage, and the men on board tried to bail the water clear.⁵ And still, when the planks gave way, water rose and the ship began to sink, the crew invoked the aid of gods.⁶ The prayers unavailing they had to catch hold of planks to be carried wherever their fate led, to unknown and dangerous places.⁷

It is interesting to notice, *en passant* that the Indian mariners "like the sea-faring Phoenicians and Babylonians of ancient times, employed the shore-sighting birds (*disākāka*) for finding the direction or land during navigation."⁸

The conclusion is that transport, on the whole, was very slow, thus obstructing the easy exchange of goods.

4.—SYSTEMS OF TRANSACTION

The act of exchange between producer and consumer, or between either and a middleman was done in different ways.

1. J. II. p. 112 ; III. p. 126 ; IV. pp. 17, 21. Cf. *Acāranga Sūtra*, II. 3, 1, 13-21. See the sculptured figures reproduced in R. K. Mookerji, *Indian Shipping*.
2. J. II. p. 112 ; IV. p. 137 ; V. p. 326 ; VI. pp. 326, 443.
3. J. VI. p. 34—"samuddo nāma appasiddhiko bahu antarāyiko.
4. J. V. p. 259.
5. J. IV. p. 16.
6. J. VI. p. 34 : "*Phalakāni, bhinnāni, tatotato udakam uggatam, nāvā majjhe samudde nimuggā, mahājano rodati paridevati nānādevatā namassati*:" the sea is still a god with the sailors in India.
7. J. I. p. 110 ; II. pp. 111, 128 ; IV. pp. 2, 142 ; V. p. 75 ; VI. p. 34.
An interesting thing to be noticed in this connection is the precautions taken just before the shipwreck ; once when the ship was about to sink, the man on board ate sugar and ghee and then smeared his garments with oil (*mattasāṭaka telena makkhivā*) and put them tightly round him and stood leaning against the mast. J. VI. p. 34. The oil-soaked robe could resist the slow freezing of the body : "The competitors in swimming even to-day do not act otherwise". Levi, *I. H. Q.* VI. p. 606.
8. J. III. pp. 126-7, 267. Cf. *R̥gveda*, VI. 62-6.

Every village had its own resident traders. Here, for the most part buying and selling were done directly, *i.e.*, between the producer and the consumer, probably in individual shops, or open market-place. A portion of the village produce was sold in the village markets for local consumption, and the surplus, if any, was handed over to the agents in the towns and thence dispatched to trade-centres in other parts of the country, or exported out of it. Imported merchandise was distributed by the same machinery working in the opposite direction. In this process, trade passed through the hands of middlemen (*vāṃjā*), whose existence cannot be doubted.

Within the towns, as we have seen, there were special streets apportioned to different products.¹ Food stuffs,² green groceries,³ and flowers for the towns⁴ were apparently brought only to the gates. Probably near the gates or outside them were also the slaughter-houses (*sūnā*) and near them the poor man and the king's chef brought their meat.⁵ And there were taverns (*pānāgārā-surāpaṇa*) for the sale of strong liquors.⁶ "The workshop" in the street was open to view, so that the *bhikhu* coming into town or village for alms, could see fletcher and carriage builder at work, no less than he could watch the peasant on field."⁷ In all these shops (*āpaṇa*) forming the bazar, articles of various kinds were displayed for sale⁸ or stored within (*antarāpaṇa*).⁹ In most of these cases buying and selling were direct (*i.e.*, between the producer and the consumer); the two notable exceptions being those of the green-grocers and the corn-factors.

It is indeed curious that we do not find any mention or clear reference either to a market-place in the town or to seasonal market days as the *Hāṭ* of the modern days, or fairs (*melās*)—the *samājas*¹⁰ or fêtes do not appear to have included any kind of market.¹¹

Another way in which the exchange of goods was carried out was by hawking, *i.e.*, the sellers going about looking out for buyers.

1. J. I. pp. 320, 356 ; II. p. 197 ; IV. p. 81.
2. See for instance, J. I. p. 361.
3. J. I. p. 442 ; II. p. 179 ; III. pp. 21-2 ; IV. p. 445 ; 448-G., 119, 449.
4. J. I. p. 120 ; IV. p. 82 ; IJ. p. 276-G. 1197.
5. J. III. pp. 100, 378 ; V. p. 458 ; VI. pp. 62, 276-G. 1196, 334.
6. J. I. pp. 121, 252, 269, 350 ; II. pp. 427, 431 ; IV. pp. 1715, 223 ; V. p. 13 ; VI. p. 328.
7. C. H. I. I. 215.
8. J. II. p. 267 ; III. p. 198, 199-G, 77 ; IV. p. 488 ; VI. p. 29.
9. J. I. p. 350 ; III. p. 406.
10. See for instance J. I. p. 423 ; III. p. 442.
11. C. H. I., I. p. 215.

Hawkers roamed about in the streets with their wares just as at present¹ and travelled from place to place² with their goods on a donkey³ or on a barrow.⁴ Horses were taken for sale to kings by the sellers.⁵

It is also interesting to note in this connection that there grew up some market-towns (*nigamagāmas*)⁶ "which served as centres of trade in a locality as the name implies and were the natural corollary of the specialized industries of the villages noticed before."⁷ They sometimes grew up at the entrance of great cities like Mithilā.⁸

Trade with the border was another feature in the business transaction of the day.⁹ "The border merchant served as a sort of entrepôt. Merchants in the capital cities established relations with the merchants on the border.¹⁰ They would load their carts with local produce and give orders to men in charge to go to their correspondents on the border and exchange it for the wares in their shops,"¹¹ or for money.¹² The wares obtained at the border were probably forest produce and also possibly goods of other countries.¹³

5.—PRICES

As already said, the exchange between producers and consumers or between either and a middleman was a "free" bargain. There were no fixed prices.¹⁴ Owing to slow transport, individualistic and small production and primitive machinery, supply was hampered. But nothing prevented the producer or the dealer from prevailing by competition,¹⁵ and also by adulteration and knavery (*kūṭakāri*),¹⁶ and thus bringing about an equation with a demand "which was largely

1. J. I. pp. 111, 205 ; II. p. 424 ; III. pp. 21, 283.
2. J. III. p. 54.
3. J. II. pp. 109-110.
4. J. IV. p. 333.
5. J. I. p. 121 ; II. pp. 31, 287.
6. J. I. p. 205 ; II. pp. 225, 232 ; III. pp. 21, 283. Cf. *Arthaśāstra*, II. 1. (*paṇyapaṭṭana*).
7. *Supra*.
8. J. VI. p. 330. Subbarao, *op. cit.*, p. 79.
9. J. I. pp. 121, 344-5 ; II. pp. 31, 287.
10. J. I. p. 451.
11. J. I. pp. 376, 378.
12. J. I. p. 404.
13. Subbarao, *op. cit.*, p. 80.
14. J. I. p. 98.
15. J. III. pp. 282, ff ; GG. 94, ff.
16. J. VI. pp. 110-G., 463 ; 113-GG., 479-80 ; 235 ; Cf. *Brahmajāla suttānta. Dialogues of the Buddha*, I. p. 6, n. *Uvāsagadasāo*, p. 18. *Kudatullakudamāna ; tappadīruvaga*.

compact of customary usage and relatively unaffected by the swifter fluctuations termed fashion."¹ Merchants were well-known for bragging (*vikatthani*).²

We may also note some practices of a more developed competition known to-day as "dealing in futures" or "cornering." We have already noticed the instance of the daring youth of Benares. Receiving the earliest intimation of the arrival of a ship in port, he proceeded to buy it up wholesale on credit and thus established a corner in foreign produce which sent up prices to his immense profit.³ The same youth had, sometime before, sent up the price of grass by a "limitation of output," in agreement with other "producers."⁴ In another instance two dealers in pots and pans apportioned the streets between themselves, each to hawk in his own district and they also agreed that "one might try in the streets which the other had already been into."⁵

Haggling over prices seems to have been not an uncommon feature of the times.⁶ We however hear of a dealer who regards this haggling as a 'killing work.'⁷

But it is not improbable that custom and fair play sense may have settled price to a great extent. Prices were fixed in terms of

1. C. H. I. I. p. 216. The principle by which the margin is pushed lower in response to increased demand is sought to be recognised in the following *gāthā* :

"A wild and savage cow that we
Had never milked before :
We milked to-day ; demand
For more milk grows ever more and more."

- J. V. p. 105G. 334. Subbarao, *op. cit.*, p. 61, n.
2. J. V. p. 425-G., 290.
3. J. I. pp. 121-2. Mrs. Rhys Davids remarks : "The outlay in this case for a carriage, a pavilion at the Benares docks, men (*purisā*), and ushers (*patihāra*) must have cut deep into his last profit of 1,000 coins, but he was 20,000 per cent. to the good as the result of it ! After this the profit of 200 and 400 per cent. reaped by the traders (J. I. p. 109), falls a little flat." C. H. I. I. p. 216. Such economic thrills are indeed rare in Ancient Indian literature and in life.
4. J. I. p. 121. Cf. Subbarao, *op. cit.*, p. 81 and n. Cf. *Kauṭilya*, IV. 2.
5. J. I. pp. 111-2. "Dividing the streets," is well-known among the coster-mongers of London : Subbarao, *op. cit.*, p. 81, n.
6. J. I. pp. 111 ff ; 196 ; II. pp. 222, 289, 425, ff ; VI. p. 113-G., 479, (*aggahena aggam kayam kāpayanti*).
7. J. I. p. 99 Cf. *Rgveda*, IV. 24. 9. The king made his purchases under special conditions. He had a valuer (*agghāpaka*) "who used to value horses, elephants and like and jewels and gold. His price was final. J. I. p. 124 ; II. p. 31.

money, though references to goods exchanged between parties are not unknown.¹ Generally, however, barter was replaced by the use of a metal currency to which we are now turning, in the next section.

6.—CURRENCY

Money, as a medium of exchange, was in use in India from very early times.² The *Jātakas* leave no doubt whatever as to the use of coins as currency in exchange. Mrs. Rhys Davids rightly observes : "The Buddhist literature reveals a society having the full use and enjoyment of plentiful coinage. The worth of every marketable commodity, from a dead mouse and a day at the festival, up to all kinds of fees, pensions, fixed loans, stored treasure and income is stated in figures of a certain coin and its fraction and that is either explicitly stated or implied to be the *kahāpana*."³

Several *Jātakas*⁴ mention a specific class of coins, viz., the *Nikkhas* which are surely golden coins, as expressly stated in some of the *gāthās*.⁵ *Nikkhas* were not the only class of gold coins known to the *Jātakas*. We frequently meet with an expression in which the words "*hiraṇṇa*" and "*suvaṇṇa*" are associated together.⁶ Dr. Bhandarkar rightly infers that *suvaṇṇa* in this as in other places where it is associated with *hiraṇṇa* must stand not for "gold" but a "type" of gold coins.⁷ We also read in the stories of gold coins of a still smaller denomination, viz., the *suvaṇṇa Māsakas*.⁸ As we shall presently see, *māsa* was a unit in the weight system of Indian coinage which differed in weight according as the coin was of gold, silver or copper. A *suvaṇṇa-Māsaka* was therefore a gold coin equal to one *māsa* in weight according to the standard of gold coinage.⁹ Thus we see that in the days of the *Jātakas* "no less than three types of gold coins were current. Of the lowest value was the *Māsaka*, of higher denomination was the *suvaṇṇa*, and of a still higher denomination, the *Nikkha*.

1. J. I. pp. 103, 109, 377-8 ; II. p. 247 ; VI. p. 519.

2. See Bhandarkar, *Ancient Indian Numismatics*, pp. 167 ff.

3. J. R. A. S. 1901, p. 318, 876.

4. J. I. pp. 375, 376-G., 88 ; IV. p. 234, 277 G-G., 63, 66 ff 460 ; G. 228, 461-G., 229-230 ; VI. pp. 462-G., 1630 ; 464-G., 1638 ; 546, 547.

5. J. IV. p. 227-G., 63, 36. Bhandarkar, *op. cit.*, pp. 147-20. On the *Niṣkas* of the *Rgveda*, as being golden coins, see Rai Sahib Manoranjan Gosh, in *Proceedings, 4th Oriental Conference*, pp. 711-22.

6. J. VI. pp. 69, 186 ; 462, 493-G., 1742.

7. *Op. cit.*, p. 51. Cf. *Manu*, VIII. 137.

8. J. IV. pp. 106, 107 ; V. p. 164.

9. Cf. The remarks of Dr. Bhandarkar, *op. cit.*, p. 53 ; *Arthaśāstra*, II. 19 ; 19. 2 seeds on *Guñjā* (=) 1 *suvaṇṇa Māsa*.

The most frequent mention, however, is that of a class of coins called *kahāpanas* (Skt. *Kārṣāpaṇas*).¹ This *kahāpana* appears to have been of three varieties, according as it was of gold, silver and copper,² though gold *kahāpana* is very seldom referred to. Thus in the *Gāmaṇi-caṇḍa Jātaka*,³ where the pair of oxen and the horses are priced at 24 and 1,000 *kahāpanas* respectively ; they must be silver *kahāpanas*, "as copper or gold *kahāpanas* would be too low or too high a price to pay for those animals."⁴

On the *Kahāpana*, Prof. Rapson's remarks make everything clear : "To both of the standard coins in question, the silver *purāṇa* of 32 *ratīs* and the copper *paṇa* of 80 *ratīs*, the same name *Kārṣāpaṇa* was sometimes applied. This double use of the term was probably in ancient times only confusing whenever the currency of one district had to be compared with that of another. We may gather both directly from the statements of the law books, and more generally from the study of the coins, that, in Ancient India, silver and copper coinage were often independent of each other and circulated in different districts. A copper currency was not necessarily regarded as merely auxiliary to the silver currency ; but a copper standard prevailed in some districts just as a silver standard prevailed in others. The word '*Kārṣāpaṇa*,' therefore may in any particular district be supposed to mean the standard coin whether of silver or copper."⁵

The *Jātaka* stories also give us the various token coins of this standard. We have *kahāpana*, *addha-kahāpana*, *pāda-kahāpana*, *Māsaka*, *addha-māsaka*, and *Kākaṇikā*,⁷ almost the lowest money.

1. J. I. pp. 112, 195, 478, 483 ; II. pp. 20, 247, 305, 424 ; III. p. 448. IV. pp. 138, 378, 449 ; VI. pp. 343, 404.

2. Cf. *Sāmaṇṭa-Pāsādikā* quoted by Bhandarkar, *op. cit.*, p. 81.

3. J. II. pp. 305-6.

4. Cf. Bhandarkar, *op. cit.*, p. 78 ; Cf. Pran Nath, *Economic Condition*, p. 109. The silver *kahāpaṇas* were later called *Purāṇas* and *Dharaṇas* : *op. cit.*, pp. 82, 92.

5. *Catalogue of Indian Coins : Andhras and Kstrapas* : Intro. pp. clxxix-x. *Kārṣāpaṇa* appears to have been so called, because in weight it conformed to one *Karṣa* or 80 *ratīs* or 146·4 grains as computed by Cunningham. The *Kahāpaṇas* are also identified with the punch-marked coins found all over India in great abundance : Bhandarkar, *op. cit.*, p. 96. For example : See *Buddhist India*, p. 106.

6. J. III. p. 448 ; Cf. also, I. p. 340.

7. J. I. p. 120 ; VI. p. 346 ; Cf. *Uttarādhayayana Sūtra*, VI. ii. Cowry-shells (*sippikāṇi*) are also mentioned once in *gāthā* ; J. I. p. 425-G., 109, but perhaps not as anything still having currency.

piece of the day.¹ The *kahāpana*, whether of silver or copper, and its smaller tokens mentioned above, were quite intimately connected not only with the commercial life but also with the daily intercourse of the period. Whether these instruments of exchange constituting, of course, a currency of standard and token coins, were issued and regulated by any Central Authority or by private guilds we have no means to ascertain.

We must, here, note the purchasing power of money or in other words, prices of ordinary commodities. A pair of oxen was worth 24 *kahāpanas*²; a nice plump dog is bought for one *kahāpana*³; a decent ass is had for 8 *kahāpanas*⁴; a fish is worth 7 *māsakas* only⁵; a bundle of grass, again, fetches one *māsaka*,⁶ and for the same small coin can be had a jar of liquor⁷; two poor lovers buy a garland, perfume and strong drink with one *māsaka*⁸; a piece of meat can be had for an *addha-māsaka* or even a *kākaṇika*,⁹ and a dead mouse is also purchased for a *kākaṇika*.¹⁰ Similarly a *māsaka* or an *addha-māsaka* is the daily wage of a day-labourer.¹¹ To hire a carriage in Benares by the hour cost 8 *kahāpanas*.¹² For the services of a young bull to pull 500 carts through a rough ford, a merchant pays 2 *kahāpanas* per cart¹³; a ferry's fare across the river is 8 *kahāpanas*,¹⁴ and the same sum seems to have been the cost of a visit to a barber.¹⁵ All these instances give a realistic picture of the various transactions of the day. Naturally, the ordinary people could not go beyond such little sums of *māsakas* and *kahāpanas*. The nobility and the rich people are almost always spoken of in terms of high expenditures. Horses

1. Kauṭilya has *half-Kāṇini* as the lowest copper coin : *Arthaśāstra*, II.

12. From the *Gaṅgamāla Jātaka*, J. III. p. 448, it appears that a *Pāda-kahāpana* equalled something more than 4 *māsakas*; and curiously enough, the commentary on the *Vinaya Pitaka*, as pointed out by Dr. Bhandarkar, tells us that in the time of Bimbisāra, five *māsakas* equalled one *Pāda* : *op. cit.*, pp. 111-2. Cf. also *C. H. I.*, I. p. 218.

2. J. II. pp. 305-6.

3. J. II. p. 247.

4. J. VI. p. 343.

5. J. II. pp. 424, 425-G., 112.

6. J. III. p. 130; Cf. IV. p. 449.

7. J. I. p. 350.

8. J. III. p. 446.

9. J. VI. p. 346.

10. J. I. p. 120.

11. J. I. p. 475; III. pp. 326, 446.

12. J. I. p. 121.

13. J. I. p. 195.

14. J. I. p. 112.

15. J. IV. p. 138.

were highly priced—the price ranging from 1,000 to 6,000 *kahāpanas*.¹ The Kāsi cloth was worth 100,000 *kahāpanas*²—a sum undreamt of by the poor class. All these figures mentioned before, are not, and cannot, however, be taken as quite exact. For the references are only legendary and not in the way of statistical figures like those given in Kauṭilya's *Arthaśāstra*.

7.—CREDIT

Credit must have been an almost indispensable factor in business even in those remote days. There was, of course, no bank system. The rich people had their own strong boxes or rooms.³ A great deal of wealth was hoarded in the form of gold and jewellery or even money and these were stowed away in a pillow⁴, or hidden (*nidāhiltvā*) in other convenient places.⁵ The nature and amount of the wealth thus hoarded was sometimes registered on gold or copper plates⁶.

People could also deposit money (*nidhi*) with their friends. But this course is not always safe, for the friend might spend away the money and then may offer his daughter in marriage instead.⁷

It is interesting to note, however, that some forms of instruments of credit did prevail. A merchant, for instance, makes a purchase on credit, by depositing his ring, probably bearing his initials or other mark of identification as security.⁸

8.—WEIGHTS AND MEASURES

Lastly, we may also note some of the notable weights and measures. Among weights we have references to *Ammaṇa*, a measure of about four bushels,⁹ *Nāli*,¹⁰ and *Pattha* (*prastha*),¹¹ for measuring grains, etc.

1. J. II. pp. 289, 305-6.
2. *Supra*.
3. J. I. pp. 351, 466 ; III. p. 129 ; IV. pp. 7, 237.
4. J. II. p. 443-G., 141 : "*Nikkham ussīsake katam*."
5. J. I. pp. 225, 227, 323, 375, 424 ; II. pp. 308, 431 ; III. pp. 25, 116, 350 ; IV. p. 256. Cf. *Uvāsagadasāo*, p. 3. "*Nihānaputtāo*"
6. J. IV. pp. 237, 488 ; VI. p. 29 ; Cf. *Sukra*, III. 376-9.
7. J. III. p. 342 ; V. pp. 116-G., 18 ; 521-Cf. *Therī Gāthā*, 44.
8. J. I. p. 121.
9. J. V. p. 297 ; Cf. *Mūlinda*, IV. 1, 19.
10. J. IV. p. 67 ; VI. pp. 360-G., 366 (*addhanālika*). Cf. "The commonest name for one of the smaller measures is *nāli* which means simply a joint of bamboo. The metal vessels are usually shaped something like hour-glasses, being narrower in the middle than at the top and bottom. *Cunningham*, quoted by Thomas, *Ancient Indian Weights*, p. 25 n.
11. J. V. p. 297.

and *Catubhāga*¹ and *Accharam*² for liquids. And among measures of distance we have *Anguli*,³ *Vidaṭṭhi*,⁴ *yatṭhi*,⁵ *kukku*,⁶ *usabha*,⁷ *gāvuta*,⁸ and *yojana*⁹ though the exact measurements of these are difficult to ascertain now.

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1. & 2. J. V. p. 385.

3. J. VI. p. 341 ; an *angula* = $\frac{3}{4}$ inch.

4. J. VI. pp. 339, 341 ; a *vidatthi* or *vitasti* is 12 *angulas* or 9 inches.

5. J. IV. p. 21 ; a *yatthi* = 2 *vitasti* or 18 inches.

6. J. III. p. 318-G., 1 ; a *kukku* = 26|11 *vidatthi* or 21'3|11 inches.

7. J. IV. p. 21 ; VI. p. 580 ; an *Usabha* = 20 *yatthis* or 30 ft.

8. J. V. p. 356 ; *gāvuta* = *gavyūti* or *goruta* (*krośa* ?) = 9 furlongs

9. References are many ; a *yojana*, or for the matter of that all other measures varied from place to place and time to time. Cf. *Arthaśāstra*, II. 19-20 ; Pran Nath, *op. cit.*, p. 80.

ISLAMIC ART AND ARCHITECTURE*

Islamic art was not like many Western artistic movements created by a nation but by a religion, which was and is nowadays the faith of many nations in many parts of the world. Each of these nations and tribes has its own taste and its own qualities. Each has a tradition of its own, which sometimes goes far back into the past and brings it with her as a dowry into the new religious community.

When the Islamic movement started, its vigour and energy were perhaps the most tremendous that the world's history has ever seen. Countries and empires, the most cultured and populated of the world, crashed down before it in an amazingly short time. The Arabian tribes, which formed the first Mohammedan armies and fought the first battles of the new faith, were primitive tribes and without great cultural interest. Their property was Mohammed's religion—as for culture they had to form one.

So in the first Islamic centuries there was no Islamic style in existence. But a determined tendency can be recognised towards an artistic ecstasy equal to the religious enthusiasm.

The chief problem was how to build the mosques. The typical mosque of the early Islamic period can hardly be called a building. It is mainly a square open courtyard, the four sides of which are bordered by arcades, covered with flat roofs. Those before the mihrab, the prayer niche, are usually multiplied and form a kind of a building containing several parallel arcades like church naves. Here was a place for the chalik separated from the congregation, the so-called maqsura. Its purpose was to protect him against his subjects, which was sometimes very necessary indeed. Near to the Mihrab a covered pulpit is set, the Mimbar, and a water fountain for ablution is to be found in the court-yard. A steeple tower, the so-called Minaret, or better Minar, stood in earlier times opposite the front of the mosques and only later became a part of the building proper. It belongs much more to the town because from its top the inhabitants of the town are summoned to attend the daily prayers. There are many theories concerning the origin of this type. The opinion which now prevails is that it was formed in the camp of the

* Summary of three lectures on Islamic Art and Architecture delivered under the auspices of the Bombay University, on the 7th, 8th and 9th February, 1935, by Dr. Ernst Cohn-Wiener, (Baroda).

Mohammedan army as a separated prayer place. A Mohammedan community standing in parallel lines and bowing rythmically reminds us very much of an army, which when praying even is ready to fight.

But an architectural style cannot be developed from a mere open space but from architectonic forms and static experience. So the Mohammedan religion had to accept the experience and the craftsmanship of the countries which the armies conquered, and with that the style of these countries became Mohammedanised.

Very often the Mohammedan architects simply took away the columns and pillars from Roman and early Christian buildings. Especially in Egypt and Northern Africa almost all the ancient mosques, such as the famous mosque of Sidi Aqba in Qairuan, the mosques of Amru, and the El Azhar in Cairo, are built with the help of older architectural fragments. For the same reason almost every early Islamic building shows a different style. The famous Dome of the rock, the Kubbet-es-Sakhra at Jerusalem, is a circular domed building. It was originally erected by Sultan Abd-el-Malik in the year 691 to cover the holy rock. This building is of a strictly Byzantine type and Herzfeld stated that it is almost a copy from the cathedral at Bosra. The mosaics too are Byzantine but have adopted many Sassanian elements. The famous Mosque at Damascus, built by the Umayyad Chalifs represents a different type. It follows more or less the courtyard-type. The site was originally occupied by a Roman temple, which the Emperor Theodosius at the end of the 4th century A. D. converted into a Christian church. The Chalif Walid I in his turn converted the church into a mosque in the early years of the 8th century and rebuilt it. We possess a most impressive description of the work. Roman columns were collected in all Syrian towns. The architects were Greek, which means trained in Byzantine style, and 1200 artists were brought from Constantinople. But the ground plan of the Roman temple-place continued perhaps through all these different periods. The mosque having been burnt to the ground twice it seemed hardly possible that much could have been left of its old glory. But during the last few years the whitewash has been removed from the walls and long rows of marvellous mosaics have been discovered. Two different styles can be recognised, those of the first style belonging to Walid's mosque, the others to a later restoration. It was perhaps the same Chalif who had the most important civil building of the time erected, the palace of Mshatta. It was an enormous square fortification in the courtyard of which, facing the entrance, the palace proper was to be erected. In this marvellous work, which was never completed, elements of the most different origin are

mixed together. The system of the main entrance was already known to the Assyrians and Babylonians and so was the disposition of the decorative work. The system of the decoration, the zigzag enclosing rosettes is also an old Asiatic one. The chief pattern is the well-known Greek acanthus leafage and the ground is filled with tendrils, winged griffons and other fantastic animals, born from Sasanian imagination.

We should call this Islamic period an eclectic period. It was the same, which collected the medical, astrological and chemical works of Greek, Indian and Persian authors and had them translated into Arabic. It was this period, which laid the foundation stone of Islamic civilisation. The earliest Islamic miniatures illustrate such scientific manuscripts and are copies from Byzantine, *i.e.*, from Greek originals.

A new nation, unknown in Asiatic history until then, was to create something like a panislamic style. It was the Turkish tribe, which should have become the fate not only of the Islamic countries, but greatly influenced the history of the world.

The Turks are a tribe of the great and extraordinary gifted Mongolian race. When history first cast a ray of light upon them they were settling in Turan, the steppes and deserts north of Persia. With much resistance they were converted to Mahomedan religion. But practically independent the Turks very soon ruled Islam as much as Islam ruled them. They moved from Turan into the richer Islamic countries, penetrated them by peaceful and war-like methods, came into them as soldiers and afterwards became the rulers of almost all of them. Towards the end of the 8th century the Chalifs of Bagdad, not feeling sure of the loyalty of their subjects, hired Turks, mostly from the Ferghana district, as a bodyguard. The Chalif Al-Mutassim Billah built for them in 838 the town of Samarra, a military town, a kind of permanent soldiers' camp. It was abandoned in 883. There were two marvellous mosques the square courtyards of which were surrounded by pillar arcades. The minars stood opposite the eastern walls and were like gigantic spiral staircases, showing the whole way upwards. The houses were richly decorated. The walls were always coated with stucco decoration. There are two different distinguishable styles one of which is decidedly Turkish. Strzygowsky compared it with the decoration of bronze ornaments mostly of horse harnesses found in old Turkish districts in Asia and Hungary. I myself saw a marvellously carved wooden piece in the very native country of the Turks, found at Ura Tübe near Samarqand. This style went with the Turks as far as Egypt. The country had once a Turkish ruler, one Achmed ibn Tulun, who came from Bokhara. In 876-879 he built the

marvellous mosque at Cairo, which bears his name. Its ground-plan and minar are nearly identical with the Samarra mosques and the pointed arches are bordered with the same ornamentation which we find in the houses at Samarra. It then became the usual decoration in Egypt. Here we have a common Islamic style and it was in fact a Turkish one.

It was during this period that a peculiar technical branch of art became visible for the first time, which was to grow into a remarkable achievement of the Mahommedan art. Most other countries did not think of the daily used vessels as artistic work at all. But the Mohammedan law forbade the use of precious vessels made of gold or silver. So to satisfy the demands of the rich people the Mohammedan potter became an artist. Highly experienced in Alchemy, they knew how to use metallic ingredients and to add to the ceramic enamel a golden or a rubyred lustre. Vases of this kind are most beautiful and the technic was practised in almost all Islamic countries.

In Egypt this Tulunid period was a merely transitory one, after which the country used again the columns and capitals and other relics of its ancient buildings. It was a new kind of rich decoration in sharply cut stucco which developed in the 12th and 13th century and appears at its height in the Muristan, the hospital built by Sultan Qalaun in 1287. The structural development began with the mosque of Sultan Hassan, built in 1360. It is the first well planned Egyptian medresse in existence. To each of the four sides of the courtyard a hall (Livan) is attached, meant for teaching one of the Islamic confessions. Each hall is covered with a pointed barrel vault. As for the outside, stress is laid for the first time on a cupola, which in this building is the structural accent.

The next step was to build the mosque and especially the cupola and the minar slimmer and higher. The most significant building of this kind is perhaps the mortuary mosque of the Sultan Kait Bey, who died in 1496. It contains a school, a hospital, a mosque and the ruler's Mausoleum, but the outside looks like a unitary building, the crown of which are cupola and minar. Both have now acquired the typical Egyptian shape being very high and slim. The most marvellous specimen of this highly finished style is an elegant fountain structure built by the same Sultan Kait Bey in Jerusalem in the enclosure of the Dome of the rock.

It is surprising that hardly any sign of influence of Egyptian architecture can be traced in Spain. This country, the Western outpost of Islam had an art completely its own. It emphasised

the arabesque, indulged in ornaments denying the value of structural expression in architecture. The Spanish mosques, the most important among which is that at Cordova, neither became a building nor got a cupola, but always continued to be a succession of parallel arcades with flat roofs. In the mosque at Cordova only one part is emphasised, the maqsura. But it is done purely by ornamentation. There are no less than five systems of arches, intermingling with each other. Four are indented arches, one system is horse shoe shaped. This ornamental ecstasy goes so far as even to make a castle the richest decorated work in the world. The famous Alhambra is in fact nothing but a castle, built by the dynasty of the Nasrides, which ruled Granada in the 13th and 14th century. There the so-called hall of the ambassadors is in itself nothing but a square room, but covered with stucco friezes, which endlessly repeat stars and arabesques. Windows are simply cut into this system and the ceiling is a stalactite decoration without any static expression.

Considering this style, we find it rather contradictory. Islamic religious law does not allow the representation of any human being or animal. So painting and sculpture could never grow. Not even miniature painting was developed in the orthodox Western Islamic countries. The only arts permitted were architecture and applied arts. These ought to be extremely logical. They are useful arts and should express their purposes. But all the suppressed sensualism, all the imagination, which was not allowed to express itself in images of beings, flowed into the ornamentation. And Islamic literature shows very much the same tendency.

It is of great advantage to look at Persian art and architecture from the monuments standing in the rich oases of the Turanian steppes and deserts. When I travelled through these districts I found and later brought into public notice a great number of so far unknown buildings, which partly fill up gaps in our knowledge of the surviving Persian monuments.

The starting point of Islamic art in Central Asia is the tomb of Sultan Ismail (died 907) the founder of the Samanid power, which stands in Bokhara. Its form is that of the dome type, of which it is the oldest known example. The pointed arch is already the typical feature. The decoration is almost entirely formed by brickwork. The Samanids were in the beginning of the 11th century vanquished by the so-called Ilekhhans or Karakhanids. Their residence was Uskend in the Eastern Ferghana quite near to the Chinese frontier. Four important buildings of this town are standing until to-day, a minar and three mausoleums. The minar, which has lost its top part

represents a type very common in Iran and Turan, a cylindrical tower, gradually diminishing as it reaches the top. It is the oldest specimen of its kind. The decoration resembles perfectly that of the oldest tomb at Uskend, most presumably that of the founder of the Karakhanid dynasty, who died 1012|13. It consists of lines of tiles combined in geometrical patterns, the ground between them filled with small stucco-leaves. This kind of decoration, sometimes without stucco leaves becomes now quite common. In Northern Persia we find two tomb-towers decorated in this way and it occurs as late as the end of the 12th century on the tombs of Mumine Chatun, wife of the Atabeg Ildegis, and of Jusuf ibn Kuseir at Nachtshevan.

The next step in the development is the façade of the tomb at Uskend where the Khakhan Jelaeddin el Hussein was buried, the date being 1152. Again the brickwork pattern dominates, very densely set. It fills the front wall completely. But real ornamentation, worked out in terracotta enters now the system, emphasising the entrance. The third mausoleum at Uskend was built in 1186|87, unfortunately we do not know for whom. Here the brick decoration has quite disappeared and perpendicular friezes filled with terracotta ornamentation dominate the façade. This decoration consists of inscriptions, arabesques and wicker-work patterns of all possible descriptions. Another outstanding monument in the Ferghana district is a tower-shaped mausoleum, standing in a very lonely site near Kassan. It looks very plain and unadorned. But the interior is most beautifully decorated. All details, such as the quaterfoil or the indented archer of the highest beauty and the details are extremely varied.

The centre of this art was not the Karakhanid court. A ruler of this dynasty, Arslan Khan Muhammed ben Suleiman, beautified about 1120 Bokhara with monuments, which have no connection with the style of Uskend. Above all he erected the famous Kalyan Minar, which is the landmark of this city. This type is, as mentioned already, very common in Iran and Turan. Examples exist at Kunja Urgenj, Termess, Firuzabad, Isfahan and at many other places. Arslan Khan moreover built a musalla, the surviving parts of which show the same Churasanic brick-decoration, as the ancient mosque at Herat and the most imposing building of Western Turkestan, Sultan Sanjar's Mausoleum at Merv.

Merv is to-day a barren spot in the desert of Kizil Kum. But it was a very old cultural site. There are not less than five ruined places next to one another, whose history stretches from the ancient Persian period right down to the 18th century A. D. The most important of them is Sultan Kala, the city of the Seljuk dynasty, which

in four lines, ruled the whole of Central and Western Asia. We know that it was very rich indeed in mosques, houses, palaces and libraries. Even to-day the double wall is still standing, which Sultan Sanjar built around his town, and Sultan Sanjar's mausoleum. He died in the year 1157. It is unquestionably one of the finest monuments of Islam. Admirable is the distribution of the ornamentation, which never disturbs the architectural forms.

There is not much left of medieval buildings in other parts of Asia. The most impressive buildings are the monuments of the Seljuk dynasty, which resided at Konja. The greatness of the ornamentation in the façades of their buildings is striking and disarms every prejudice against Mohammedan art. The minars of this style are very peculiar. We would call them perhaps fluted, but convexly fluted. We come across such forms in all parts of Asia, where Turkish dynasties ruled. It is doubtless again a Turkish contribution to the Mohammedan art. Its most perfect feature is shown in two mausoleums in Churasan, the architectufal idea of which seems to be that of a tent, the stuff-walls falling in folds. A fortress at Merv and a Musalla between Samarkand and Bukhara have their walls formed in the same style. In Jar Kurghan, near the Oxus river stands a convexly fluted minar and the Kutb Minar at Delhi is a building of the same kind, but richer, many times multiplied and inserting edged pillars between the convex mouldings.

The most dreadful event in the history of Asia was the raid of Jenghiskhan about 1220. A stupid offence of the Chwaresmshah gave the pretext for it. With the utmost brutality Jenghiskhan destroyed the most flourishing cities in Central Asia, such as Kunja Urgenj, Merv, Bokhara and Samarkand and killed a great part of the inhabitants. Nothing seems to have survived but a poor necropolis, dated 1340|41, at Kassin in the Northern Ferghana, and its crude style and clumsy wording testifies the cultural decay. But Persia proper does not share the darkness of this age. The Mongol dynasty of the so-called Ilkhans which descended from Jenghiskhan raised the country to new splendour. Khodabende Khan built his mausoleum in Sultanieh, which enhances the greatness of Sultan Sanjar's tomb at Merv, being octagonal and rising with a cupola. The interior decoration is now at an enormous cultural height. There are stucco-mihrabs in the mosques of Isfahan and Veramin, turning the flat ornaments into plastically graduated ones. The inner walls of the Inamzadehs were coated with fayence tiles of metallic lustre culminating in marvellous mihrabs.

But the enamel was not limited to the flat tiles. This marvellous technic spread out and joined the sharply cut terracotta-decoration, such as formerly decorating the façades of Uskend. Four buildings are

standing in Turkestan, overflowing the terracotta-decoration with sky-blue, dark-blue and white enamel. Three are the oldest buildings at the most holy spot in Samarqand, one of them built in 1334|5, being the shrine of Kasim ibn Abbas, the living king (Shah, Sindah) himself. The fourth is the tomb of a Mongol prince Bayan Khuli Khan, who was assassinated in the year 1357 and buried outside the walls of Bokhara. It seems, that this style derived from Eastern Churasan. A Liwan which bears the same kind of decoration stands in Konja in Asia Minor and the inscription describes one Mohammed from Tus the artist.

This splendid period was to create Islamic painting which according to the religious law could be only miniature painting. It was easier for these Mongol princes to overcome the prejudice, than for any born orthodox Moslem. But art was almost entirely confined to their countries, whilst others were suffering badly from the after-effects of Jenghiskhan's raid. That Islamic art obtained again a centre and arose to new richness and splendour we may safely ascribe to the great personality of Tamerlane.

Tamerlane was by no means, like Jenghiskhan, a mere destroyer. He was fond of building palaces and mosques and rebuilding holy shrines. Carrying away by force the artists from the cities he conquered to Samarqand, he made Turkestan the actual artistic centre of the Islamic world. There is no important building outside this country belonging to Tamerlane's period.

After the year 1370, when safely in possession of Samarqand he began immediately to fill his residence with splendid buildings. No less than 18 mausoleums form the splendid necropolis of the so-called Shah Sindah. They follow mostly the Churasanic style. But Turkish, Persian and even Chinese elements and techniques are mixed with the decoration. When Timur was at the very height of his power, controlling practically the whole Islamic world, his taste grew to the most exaggerated demands. From the Persian style, which was very monumental in itself, his architects developed structures on quite an exaggerated scale.

There are two monuments outside Samarqand which form the transition. The one is the mosque of Choja Achmad Yassawi in the town of Turkestan, slightly to the North of Samarqand built in 1397 by a Persian artist from Isfahan. It is an enormous square building, a cubic block, from which two domes rise, one covering the mosque proper and the other the tomb of the Saint. This second dome is already melon-shaped. The entrance is flanked by two towers like that of a fortress, a most extraordinary form, which is certainly a product of Timur's warlike mind. This mosque has the distinction

of being the only one in Inner Asia that has kept almost intact the whole of its furniture. It possesses two beautifully carved wooden doors with interlaced bronze handles, two enormous bronze candlesticks, one enormous bronze vessel of more than a man's height and some smaller objects.

The second monument of these years of transition is a palace in Timur's birth place Kesh, now called Shahri Sjabs, finished in 1396. This building is one of the marvels of the world. We possess a description of its original features by the Spanish ambassador Clavijo, sent to Timur by the King Henry III. By combining this description with the palace as it stands to-day, covered with enamelled tiles, we get a very interesting result. It proves how strong the tradition of Asiatic art was. The system is not only the same as that of early Islamic palaces, such as Mshatta and Balkuvara, but goes back to the Assyrian palaces at Nimrud and Chorsabad, and has its surface completely covered with enamelled tiles, as the Ishtar Gate at Babylon. Timur was apparently very attached to this place, where he was born, and embellished it by means of many buildings. But it was Samarqand, which he appreciated most. The most prominent building in the city is the mosque Bibi Chanim, which Timur built (1398 to 1405) in memory of his wife. With its monumental gateway, two side-buildings and a domed main mosque it is the first known specimen of the classical Friday mosques. The second masterpiece of this period is Timur's own mausoleum at Samarqand, the so-called Guri-mir. Above an octagonal structure a lofty cylindrical tambour rises, on the top of which a melon-shaped dome is set. It is the ancient Turkish form, but it enhances by far the ideas of the mausoleums of Sultan Sanjar and Khodabende Khan. Timur died in 1405, when he was just preparing for war against China.

There was no artistic centre after his death, but in many places arts were flourishing. At Samarqand, Timur's grandson Ulugh Beg built a famous observatory and the beautiful mosque, which bears his name. The building is a transformation of Bibi Chanim into a medressa. But the decoration is richer and the fayence mosaic almost the only technic used. He favoured this luxurious technic, even when finishing buildings, founded by Timur himself. This style survived in Turkestan almost to our own days. Even the Sheibanid dynasty did not change it.

During Ulugh Beg's time another Timurið dynasty, which derived from Shah Ruck Bahadur, held sway over Churasan, residing in Herat. There are some ruins of buildings left, but the taste was obviously more cultivated than strong, and turned to the lesser arts. It was perhaps here, that the so-called Persian carpet was created and

certainly the Persian miniature painting started its glorious career from this court. Its most famous artist was Behzad, the best prey, when in 1508 the dynasty of Herat was conquered by the Persian Safavids.

Through the whole history of art we find a rule which governs artistic evolution all over the world. Art always begins strong, then grows more spiritual and delicate and becomes imposing and magnificent at last. So was the evolution of European and of Chinese art and so that of Islamic art.

At the top of the development we find in all Islamic countries an art most imposing and magnificent. It is represented by the art of the Turks in Istanbul (Constantinople), of the Sefevids in Persia and of the Mogul emperors in India.

The Turkish art has a peculiar greatness, based on the warlike strength of the nation. Conquerors as they are, they tried to develop the most perfect specimen of architecture they noticed in Constantinople, the former church of Hagia Sophia. It was a very difficult task, this church having one of the boldest structures in the whole history of architecture. But they succeeded and Sinan, one of the great geniuses in art, built a series of domed mosques, which have not many equals in the world. Many Turkish mosques are covered with enamelled tiles, which enrich the original Persian patterns with naturalistic flower designs.

Later Persian art has its glory not in architecture, but in the lesser arts. Its most famous products are the Persian carpets. There are various kinds, such as carpets with flower design, with arabesques, the monumental vase-carpets and those with landscapes and hunting scenes, these perhaps designed by artist painters. There were very famous Persian painters at the courts of Shah Tamasp and Shah Abbas. Chinese influence was very strong in all Persian art of this time and contributed many patterns to the ornamental designs.

But the example of Mohammedan art in India demonstrates that the importance of influences is usually overestimated. The elements of Indian Mohammedan art came from Persia. But they were not adopted. They became elements of peculiar Indian styles. Pillars and cupolas have a material power, which is quite national. The Kutb Minar at Delhi multiplies the Turkish elements. The mosques at Ahmedabad and Champaner are mixing Mohammedan and Hindu elements into extraordinary richness and the mosques and tombs of the Mogul emperors, based on a renewed Persian influence, are perfect expressions of the Indian taste. It is perhaps most significant, that the famous Mogul miniatures are very realistic in their

way and prefer portraits and scenes from daily life, quite unlike any other Islamic art.

The rules for Mohammedan art are given by religion and each Mohammedan nation follows them. But every Mohammedan nation has its own style. Islam is a spiritual world, in which many nations and tribes found their places and I had the opportunity to form their own art and to live their own lives.

ERNST COHN-WIENER.

THE PARITY OF INDIAN COTTON*

As there is a lot of popular misunderstanding on the "Parity of Indian Cotton" and as the subject in all its ramifications is of interest not only to students of Indian cotton but also to students of economics and of rural welfare, it is felt that the following brief study may be useful to readers of the University Journal.

The most usual question one is asked not merely by laymen but also by people who ought to know better, like people in charge of mills or of Government departments, is, what is the normal parity of Indian cotton? They imagine that there is a fixed parity or a fixed relationship, say, between the price of New York futures and Broach, or Broach and Oomraş, or Bengal and Broach: that if there is a disturbance of this fixed relationship—which, by the way, must be a carefully guarded trade secret—it would be a profitable operation to sell what is higher in price and buy what is lower in price. Unfortunately, there are many people who imagine such relationships *do* exist and then operate on the same, to find themselves saddled with losses when what they considered low in parity goes lower and what they considered high in parity goes higher. They then declare that it must be somebody else's fault and end by blaming the authorities, say, the Government or the East India Cotton Association. Or they hit upon some technical market factors like the operation of Teji-mandi or of some big Marwari speculator who happens, or appears to be, making money and pass on all the blame for their losses to such technical factors. Psychologically speaking, this is the sub-conscious complex behind a lot of criticism in the Press.

The expression "Parity of Cotton" is used to denote comparative or relative price, just as the expression "naval parity" is used to denote comparative strength. The parity of Indian cotton, in general parlance, means the price of Indian cotton as compared with the price of American cotton, because America is the largest single producer of cotton. It is usual to compare the two prices by comparing the quotation of New York Futures with the quotation of Broach, *i.e.*, the most important Indian Contract.

Before one can compare the two prices, one must be in a position to reduce them to a common denominator or to express

* This study formed part of a speech delivered by the writer at the Sydenham College of Commerce and Economics on February 26, 1935.

them in the same terms, and to do this, one must first understand what the different contracts mean. Half the troubles of the cotton speculator would vanish if he always had at the back of his mind what these different contracts represented. The quotation for Broach April|May means the price of Broach cotton, of average staple and fully-good standard, per candy of 784 lbs. expressed in Rupees, for delivery in April or May at the seller's option, with the additional right to the seller of tendering certain specified growths like Dholleras or Surats at market differences. Similarly New York May means the price, in Dollar cents per lb. of American cotton, $\frac{7}{8}$ " staple and middling standard, delivered in May, with the option to the seller of tendering a certain fairly wide range of standards and staple lengths at market differences. Similarly the Liverpool May contract means the price of the same cotton delivered in Liverpool, with the same option to the seller.

Further, the New York Futures contract represents cotton delivered in New York or any one of eight designated ports in the U.S.A. Liverpool cotton is understood to represent cotton in Liverpool and Broach contract is understood to represent cotton in Bombay. In Bombay, the price is expressed in so many rupees per candy, in New York in so many cents per lb. gross weight and in Liverpool in so many pence and hundredths of pence per lb. net weight.

The comparison can be made by reducing the pence per lb. to rupees per candy, or vice versa, taking the current rate of exchange : or the cents per lb. to rupees per candy, taking the Rupee-Dollar exchange, and allowing for the fact that the New York price is the gross price and includes the tare, conventionally estimated at 6%. Taking the quotation on December 2, 1934, say, New York at 12.80 cents and the Rupee-Dollar cross rate at 2.70, one arrives at a price of New York of Rs. 271|- per candy, which comes to Rs. 287, if allowance is made for the net and gross weights. The Bombay quotation at Rs. 236|- works out to Rs. 287 minus Rs. 236, *i.e.*, Rs. 51|- lower than New York. Liverpool at 6.80d per lb. works out to Rs. 296 per candy at 1|6 exchange. Hence Bombay is Rs. 60 lower than Liverpool.

It will be noticed that while the New York contracts work out to Rs. 287, the Liverpool contract works out to Rs. 296, *i.e.*, Rs. 9 higher. This is explained by the cost of carrying cotton from the U.S.A. to Liverpool, and may be considered normal. We need not enter into the further details of the Liverpool-New York straddle here.

We have examined the crudest, but the most usual and fundamentally correct, way of expressing price differences. We have

found that Bombay is Rs. 60 lower than Liverpool, but it does not follow that Bombay is so much lower in parity. We have still to make allowances for the difference in the spinning performances of the two cottons. The Broach staple is shorter and weaker, and let us assume that Broach should be Rs. 50|- lower because of its inferior performance. Then it would be a correct thing to say that Broach is Rs. 10 lower in parity with Liverpool Americans. It must be mentioned here that the assumption that the difference in the value of Broach and Americans is Rs. 50 is pure guess-work, and what is more, the difference in value is not an absolute quantum but a variable function. If Liverpool cotton was a shilling a pound, the value of Broach would not be Rs. 50 lower but possibly Rs. 100 lower. We have, therefore, to refine our ideas and methods of working out parities and try to express them as percentages. We may suggest that Broach cotton is intrinsically 10% lower in value than American and the relative parity should be watched accordingly, and if Broach is 15% lower than American in absolute price, we may say that Broach is 5% lower in parity. But this again is an assumption.

The difference in price can also be expressed in pence per lb. instead of Rupees per candy. In the above case, we have Broach Rs. 236 with Liverpool at 6.80. Broach at Rs. 236 works out to 5.42*d* per lb., so that the parity difference is 1.38*d*. If Broach is Rs. 242 and Liverpool 6.85*d* as on December 30, the difference is 6.85 minus 5.55 :: 1.30. In the Bombay Cotton Annual, price differences are worked out in this manner from 1922 to 1933, month by month. The narrowest difference was reached in March, 1932, when Broach was only 0.17*d* lower than Liverpool, or a percentage of just over 3 per cent. This was due to the short crop in India in 1931-32. The widest difference was in December 1923 when it was as much as 5.99*d* or a Liverpool quotation of 20*d* or a percentage of 34.95. The present difference works about to a percentage of about 20. It would seem this difference in price tends to widen, not only absolutely but as a percentage, when the price level is very high. But it would be dangerous to generalise, for reasons which will be explained hereafter.

In the adjoining Table, I have worked out the difference in price between Liverpool and Bombay as a percentage, the difference being expressed as a percentage of the price of Liverpool futures. It will be noticed that the percentage is as high as 30 in January 1934 and as low as 3.2 in February, 1932. So here is food for thought for the people who believe in a "fixed parity" between Liverpool and Bombay : by the way, it may be pointed out that in January

1924, Liverpool futures were nearly 20*d* and Broach Rs. 626, while in February 1932, the former were down to 5*d* and the latter to Rs. 206.

The relative value, as explained above, is not a fixed percentage but a variable function. It is ultimately determined by a number of factors, the most important of which are :—

1. The relative supply and demand.
2. The relative character of each year's crops.
3. The cost of transport to the point of consumption.
4. Exchange restrictions and tariffs.
5. Artificial price regulations etc.
6. Technical factors like attempts to corner etc.

We will now give a few illustrations to show the working of each of these. If there is a small crop in India and a large crop in the U.S.A., Indian cotton is bound to rule higher in parity than American cotton, to the point to which the consumption of Indian cotton is restricted and the consumption of American cotton is expanded so as to bring about an adjustment of the demand to the supply. The reverse is equally true in case the Indian crop is a large one as in 1924-25 and 1925-26, when the Indian crop was actually very nearly 7 million bales and broach April-May ruled nearly Rs. 100 lower than Americans at one time or other. In 1932, when we had a small crop, Broach at one time ruled about as high as American cotton or only a few points lower. The point can be explained in another way. If the Bengal crop is small, the price of Bengal will go up in relation to Broach as the world must have, say, a certain number of cotton blankets and no amount of previous statistics will help to keep down the price of Bengals which will go up till the demand for blankets is reduced and the manufacture thereof becomes no longer profitable.

The next factor is the character or quality of the crop. If the crop of a certain year shows better staple, it will spin higher counts and its price in the world's crop will be relatively higher. This is no doubt obvious.

The third factor is that of transport—in a more general sense than the mere cost of transport. The relative adjustment of parity is brought about ultimately by the competition of similar growths of cotton at the points of consumption. A substantial portion of the Indian crop has to be exported and has to compete in the world's markets with American and other growths. We have therefore to take into account the cost of transporting Indian cotton to the world's markets—like Japan, Europe, etc.—and the price of Indian

cotton as laid down in these markets is decided by the price of American or other cotton which is brought there for consumption. It is because of this fact that the Indian crop, as a whole, cannot benefit by the import duty on raw cotton.

But the case of Indian staple cotton is different. Here the total Indian supply is smaller than the total Indian requirements, with the result that the price of Indian staple cotton, like Navsari, can go up till it reaches the level at which American cotton can be laid down in India. This has to pay an import duty of Rs. 24-8 per candy, and so, Indian staple cotton cannot be said to be too high in parity till it becomes dearer than American or other foreign cotton laid down in India, duty paid. But should the Indian staple cotton crop exceed our requirements, it would have to be exported, and it would have to rule at the level at which it could compete with American cotton in the common markets like Japan. The price of Indian staple cotton will, in that case, at least once in the season have to fall below the price at which American cotton can be imported in Bombay, by Rs. 24-8 per candy (import duty) and the cost of transport of Indian cotton to the foreign consuming countries. The two points explained above denote the maximum and minimum price at which Indian staple cotton would rule in India.

The above illustration also shows the importance of tariffs ; exchange restrictions or discriminatory quotas or boycotts play a similar part in determining the relative price levels and their importance will be felt increasingly in the future, if "economic nationalism" continues to grow at the present rate.

Further, we have the most important recent price factor, *viz.*, the American attempts at price stabilisation. In 1934, America was financing some 7 million bales at 12 cents per lb., so that American cotton could not very well sell for long under the equivalent price of this loan. When Indian cotton which had no such support continued to decline relatively to American cotton, there was a hue and cry in India. But Indian cotton continued to decline till her surplus supplies were absorbed and recovered only after her surplus supplies were absorbed, and then there was a sharp reduction in the Indian crop early in 1935.

Finally, there are such purely technical or local factors affecting either Indian or American cotton, and unduly raising or lowering it. Among these may be included attempts to corner or to "bear raid", attempts to tamper with one particular contract by manipulating spot rates or the machinery of an exchange. As explained at the very start, the effect of such factors is nearly always exaggerated ;

ninety-five times out of hundred, such attempts fail, as world forces are stronger than any technical factors. Bodies like the New York Cotton Exchange or the East India Cotton Association can at best regulate markets and see that a fair deal is exercised between buyer and seller but they cannot stabilise prices unless they have money or the right to create paper money, like the American Government.

We have seen that a large number of factors is involved in the working out of the parity of Indian cotton. The number of factors, ponderable and imponderable, is in fact so large that they cannot be reduced to an algebraic equation. The glorious uncertainty, and the world-wide outlook which these factors imply, constitute the chief intellectual attraction of the cotton trade.

Table showing the Parity each month between Mgd. Broach and Liverpool Futures, expressed as a percentage of the latter.

(Values of Broach per candy of 784 lbs.—converted into pence per lb. at the ruling rate of exchange for Telegraphic Transfers on London.)

	Liverpool (Pence per lb.)	Broach (Rs. per candy)	Difference between L'pool & Br. (Pence per lb.)	Parity as percentage of Liverpool.
1923				
Jan.	14.89	499	4.35	29.2
Feb.	15.38	537	4.29	28.0
Mar.	15.73	545	4.53	28.7
Apr.	15.01	522	4.26	28.3
May	13.98	515	3.41	24.5
Jun.	12.39	476	2.62	21.2
Jul.	12.10	456	2.61	19.3
Aug.	12.78	446	3.71	29.0
Sep.	14.74	494	4.58	31.2
Oct.	15.63	527	4.23	27.0
Nov.	18.53	606	5.46	30.1
Dec.	20.00	643	5.99	30.0
1924				
Jan.	19.55	626	5.88	30.1
Feb.	18.36	605	5.39	29.5
Mar.	16.58	563	4.60	27.7
Apr.	17.49	572	5.25	30.0
May	17.25	576	4.91	28.5
Jun.	14.40	524	3.10	21.5
Jul.	14.89	513	3.63	24.5
Aug.	14.75	513	3.47	23.6
Sep.	13.29	495	2.24	16.9
Oct.	13.50	461	2.93	21.6
Nov.	13.39	463	2.86	21.4
Dec.	13.10	457	2.56	19.5

	Liverpool (Pence per Lb.)	Broach (Rs. per candy)	Difference between L'Pool & Br. (Pence per lb.)	Parity as Percentage of Liverpool.
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1925

Jan.	12.92	460	2.37	18.3
Feb.	13.35	481	2.32	17.4
Mar.	13.77	478	2.85	20.7
Apr.	13.17	460	2.69	20.4
May	12.37	447	2.14	17.3
Jun.	12.18	420	2.64	20.9
Jul.	12.74	423	2.99	23.3
Aug.	12.34	420	2.65	21.5
Sep.	12.39	422	2.62	21.2
Oct.	11.32	409	1.86	16.4
Nov.	10.36	388	1.38	13.3
Dec.	9.86	362	1.49	15.1

1926

Jan.	10.24	358	1.95	19.0
Feb.	10.00	357	1.75	17.5
Mar.	9.43	355	1.25	13.3
Apr.	9.41	339	1.71	18.2
May	9.56	336	1.92	20.0
Jun.	8.87	321	1.54	17.4
Jul.	9.01	320	1.71	19.0
Aug.	9.04	321	1.70	18.7
Sep.	8.81	315	1.62	18.3
Oct.	7.15	266	1.10	15.4
Nov.	6.91	255	1.12	16.2
Dec.	6.66	246	1.08	16.2

1927

Jan.	7.06	258	1.15	16.3
Feb.	7.39	276	1.08	14.6
Mar.	7.50	297	0.72	9.6
Apr.	7.62	286	1.07	14.1
May	8.41	319	1.15	13.7
Jun.	9.20	341	1.42	15.6
Jul.	9.80	361	1.59	16.2
Aug.	10.74	402	1.42	13.2
Sep.	11.71	445	1.46	12.4
Oct.	11.20	409	1.77	15.8
Nov.	10.74	392	1.71	16.0
Dec.	10.31	378	1.61	15.6

1928

Jan.	9.88	367	1.42	14.2
Feb.	9.59	357	1.41	14.7
Mar.	10.08	366	1.68	16.6
Apr.	10.73	370	2.24	20.8
May	11.20	392	2.22	19.8
Jun.	10.95	390	2.03	18.7
Jul.	11.08	400	1.96	17.6
Aug.	9.97	359	1.74	17.5
Sep.	9.59	338	1.86	19.4
Oct.	10.02	356	1.83	18.2
Nov.	10.21	354	2.08	20.4
Dec.	10.43	361	2.13	20.5

	Liverpool (Pence per lb.)	Broach (Rs. per candy)	Difference between L'pool & Br. (Pence per lb.)	Parity as percentage of Liverpool.
1929				
Jan.	10-35	357	2-14	20-7
Feb.	10-32	358	2-12	20-6
Mar.	10-79	368	2-35	21-7
Apr.	10-88	345	2-49	24-0
May.	9-83	335	2-25	22-7
Jun.	9-92	333	2-36	23-8
Jul.	9-94	336	2-32	23-4
Aug.	10-00	343	2-22	22-2
Sep.	10-15	343	2-35	23-2
Oct.	10-00	338	2-32	23-2
Nov.	9-52	321	2-22	23-5
Dec.	9-38	316	2-16	22-9
1930				
Jan.	9-25	301	2-37	25-8
Feb.	8-37	267	2-29	27-3
Mar.	8-00	257	2-16	27-0
Apr.	8-24	258	2-38	29-0
May	8-03	260	2-13	26-5
Jun.	7-35	228	2-19	29-9
Jul.	7-08	222	2-05	29-0
Aug.	6-60	213	1-67	25-6
Sep.	6-18	206	1-52	24-5
Oct.	5-63	198	1-14	20-3
Nov.	6-13	200	1-60	26-1
Dec.	5-51	177	1-51	27-4
1931				
Jan.	5-47	184	1-31	24-0
Feb.	5-90	211	1-12	19-0
Mar.	6-02	207	1-32	22-0
Apr.	5-48	192	1-12	20-5
May	5-13	182	1-00	19-4
Jun.	4-79	175	0-88	17-3
July	5-29	191	0-96	18-1
Aug.	4-11	160	0-49	11-9
Sep.	4-25	154	0-76	17-8
Oct.	4-50	172	0-59	13-1
Nov.	4-75	186	0-46	9-7
Dec.	4-87	195	0-37	7-8
1932				
Jan.	5-08	206	0-33	6-5
Feb.	5-39	225	0-19	3-5
Mar.	5-09	213	0-17	3-7
Apr.	4-55	182	0-37	8-1
May	4-22	175	0-22	5-2
Jun.	3-96	157	0-37	9-4
July	4-59	184	0-36	7-8
Aug.	5-71	221	0-62	10-8
Sep.	5-93	230	0-66	11-0
Oct.	5-31	211	0-43	8-1
Nov.	5-25	210	0-39	7-4
Dec.	4-99	198	0-40	8-0

	Liverpool (Pence per lb.)	Broach (Rs. per candy)	Difference between L'pool & Br. (Pence per lb.)	Parity as percentage of L'pool.
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1933.

Jan.	5.01	200	0.39	7.8
Feb.	4.77	183	0.54	11.3
Mar.	4.87	180	0.74	15.2
Apr.	5.08	177	1.01	19.8
May	5.89	221	0.81	13.8
June	6.09	229	0.82	13.5
July	6.21	231	0.90	14.5
Aug.	5.70	209	0.89	15.6
Sep.	5.49	200	0.90	16.4
Oct.	5.38	190	1.02	19.0
Nov.	5.06	183	0.89	17.6
Dec.	5.09	180	0.96	18.9

1934.

Jan.	5.64	197	1.11	19.7
Feb.	6.26	209	1.46	23.3
Mar.	6.20	205	1.48	23.9
Apr.	5.98	198	1.38	23.3
May	5.88	194	1.43	24.3
Jun.	6.39	209	1.60	25.0
July.	6.63	222	1.52	22.9
Aug.	6.91	228	1.67	24.2
Sep.	6.75	217	1.76	26.0
Oct.	6.55	209	1.75	26.7
Nov.	6.54	215	1.60	23.6
Dec.	6.74	230	1.45	21.4
Jan. 1935.	6.82	246	1.16	17.1

R. G. SARAIYA.

* The figures for Liverpool and Broach are taken from the Bombay Cotton Annual.

LIMITATIONS OF CANE SUGAR MANUFACTURE

Importance of Indian Sugar Industry :—

That the world's sugar industry is passing through a period of revolution is scarcely news even to a superficial observer. The changes that have taken, and are still taking, place in the industry's commercial and economic structure are, too patent to need enumeration. Among them all, however, none is more striking to any one acquainted with the history of sugar, nor more dramatically significant as the sign of a new era, than the metamorphosis which has come over the Indian sugar industry during the last three or four years. From being an annual importer of about a million tons of white sugar valued at Rs. 12 crores, as late as 1929-30, the recent rapid expansion of sugar industry has drastically curtailed the quantity and value of imports, and the time is not far off when India may become an exporting country. This has come as a surprise, particularly to the westerner apt to blackmail Indian capital and capitalist, so that to-day we have about 150 sugar factories representing a total investment of over Rs. 25 crores and giving employment to about a lakh of workers. It stands second only to cotton industry. This is, however, only a part of the story. Sugar factories constitute only a part of the Indian sugar industry. Therefore, it is a relief to note that Indian sugar industry, which was an object of mild solicitude, has passed the stage when it was smiled at by other countries and has become a serious competitor of the importer who had a quasi-monopoly in the Indian market.

Agricultural Aspect :—

Indian sugar industry has two aspects, agricultural and industrial. India being primarily an agricultural country, the cultivation of sugar holds a very prominent place in its economy. From the relative position of different provinces as producers of sugar cane,¹ it is evident that the cultivation of cane holds a unique place in the sugar cane belt. It is the most important and perhaps the only cash crop in the sugar cane belt. The cultivation of cotton is not well adapted to the soil and jute can hardly be a good substitute for sugar cane. The area under tobacco is already too high to admit

(1) Vide, *Review of Sugar Trade*, 1930-31.

of any further extension. Therefore, none of the cash crops can be a profitable substitute for cane. Rightly the Tariff Board remarks that in the past over a period of years the return from cane has been consistently greater than that from any other crop except jute.¹ This is partly due to wide home market. The price of most Indian staple crops is determined by the conditions of the world market because the home market is insufficient to absorb the total production. In the case of crops cultivated for export the position of the agriculturist is affected by world factors, but the unlimited extent of the home market for sugar relieves the agriculturist from the vagaries of the world market. A protected and wide home market for sugar affords great relief to the agricultural population, for cane crop is the most important crop which helps the cultivator to pay off his rent and irrigation dues and to make provision for those necessities of life for which cash payment is required. The cane crop therefore is profitable both to the agriculturist and the Government. It is important to the Government, firstly, because the cane crop being an important cash crop, the Government is able to collect land revenue with greater ease and at higher rate. In fact, the ability of the cultivator to pay his rent is conditioned largely by the price he fetches for such valuable crops. This is especially true at present when India, with other countries, is passing through the most acute depression, coupled with the political unrest and agricultural crisis.² Cane crop gives substantial relief. Secondly, a substantial portion of the total irrigation revenue derived by the Government is due to the cane crop.

It should also be noted that cane encourages a more intensive system of agriculture because the price fetched by the crop offers sufficient inducement to the cultivator for making adequate provision for manures, water, deep ploughing, etc. No wonder then if in certain parts of the United Provinces many tube wells have been sunk to lift water for cane cultivation.³ Besides, the cane cultivation holds, throughout India, a recognised place in crop rotation. It adds to the productivity of soil because the yield of crops grown

(1) Vide, *Report*, para. 30.

(2) The severity of depression is more keenly felt because the prices of agricultural products have fallen lower than those of the manufactured products and therefore the cultivator with his reduced purchasing power and higher incidence of land revenue is pressed heavily.

Refer Agricultural Crisis League, Sir A. Chatterjee's Note.

(3) For details, see *Indian Tariff Board Evidence*, Vol. II, p. 43.

after sugar cane is generally speaking considerably higher than that after other rotation crops. So also, the cane crop is an important source of cattle fodder, especially as it comes at a time when grass gets scarce ; from December to March, when the ordinary fodder is falling off, sugar cane crop keeps the cattle in better condition. It is estimated that one acre of cane supplies one and a half tons of cattle food in the shape of tops and edible leaves.¹

Industrial Aspect :

The industrial aspect of Indian sugar industry is no less important, the three constituent parts of the industry being gur, deshi or khandsari sugar, and factory sugar. Indian sugar industry occupies unique position replete with potentialities because India, while one of the largest growers of cane and one of the biggest manufacturers of sugar,² has also been a customer for about a steady million tons of white sugar. Thus, India not only consumes what she produces but has been paying an annual sum of about 12 crores of rupees for her imports of white sugar, mainly from Java. Therefore, the Indian sugar industry enjoys a decided advantage over those of other countries in that it is favoured with *wide home market*, as is evident from her imports of white sugar and the growth in demand recorded in the recent years. Other important sugar producing countries, like Java, Cuba, Hawaii and Mauritius, have practically no home market and depend primarily on the export trade. The Indian Tariff Board has estimated the extent of the home market and has corroborated the aforesaid facts. Recent development in our sugar industry has been feasible primarily because of the existence of this wide protected home market.

The Indian sugar industry, right from the cultivation of the crop to the emergence of white sugar from the modern up-to-date factory *affords employment to large number of capitalists and labourers*. About 15 million people are directly concerned in the cultiva-

(1) Vide, *Report of the Tariff Board*, para. 31.

(2) As regards the home market India at present imports approximately one million tons of white sugar annually ; about 100,000 tons is manufactured in India in refineries or central factories, while a varying amount estimated at 200,000 to 250,000 tons is manufactured by Khandesaris mainly in Rohilkhand by the "bel" method. In addition to this some 2½ million tons of gur are consumed each year. The total consumption of gur and sugar in the country may be valued at not far short of Rs. 60 crores annually.

Vide, *Report of the Tariff Board*, para. 21.

tion of cane.¹ The majority of the central factories being established in the rural areas, in order to obtain fresh supplies of cane, draw their labour supplies from the surrounding villages, and thus afford employment to agricultural population in the period between the kharif and rabi harvest when the agricultural operations are slack. This is to the mutual advantage of both the parties ; the employer gets an adequate supply of cheap labour and the employees make the best use of the time which they would otherwise have wasted in loitering and idleness. The average wage paid at the Indian factories is about 8 annas a day, which compares very favourably with the wages paid in other countries and shows that the industry enjoys incomparative advantage in respect of the labour supply. It has been aptly stated that field labour in India is generally abundant and quite good.² In Java, wages are low as compared with other countries, but a little higher as compared with India.³ In the Philippines the wages are round about 1s. 7d. a day plus half that value of rice, equal to about 2s. 4d. a day.⁴ In Mauritius wages are about 3s. a day.⁵ Cuba pays about 5s. a day and Hawaii over 6s. In Queensland the minimum wage is round about 17s.

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- (1) According to the estimate of Mr. Burt something like 13 million people are dependent upon the industry in one way or another. Explaining as to how he arrived at this estimate, Mr. Burt says : " There are three million acres of cane land in India and even in the best cane districts cane does not occupy more than 15 per cent. of the cultivated area, so that gives 20 million acres of holdings on which cane is grown. If you take the average holding to be as large as 6 acres, which is rather a high figure, that means 3-1/3 million of holdings, and if you allow 4 people as concerned in the working of a single holding, that will give you 13 million people, in other words 4 to 5 people per acre of cane." Vide, Evidence, Vol. II, p. 4.

But this estimate, according to Dr. Mathai, errs on the side of safety and conservatism, and the number of people in fact dependent upon the cane crop is far more than the above estimate.

- (2) Dr. Barber's Paper, Imperial Sugar Cane Research Conference, 1931, p. 35.
- (3) Unskilled labour is paid 10d. a day ; careful factory worker deserves from 11d. to 3s. according to the skill required, and this is done by the Chinese, of whom there are large numbers in the island.
- (4) The total wages earned during the season is about £9-13-0 (10% having been deducted for the agent).
- (5) The labour is almost entirely Indian and is roughly divided into casual and permanent. According to Maxwell, in 1923 the scale of wages for casual labourer was 3s. per day for 26 days in the month and during cropping season 4s. 6d.

It is estimated that the average sugar factory employs from 200 to 300 men throughout the year and about 1,000 men in the working season. Not an inconsiderable number of people are employed in the preparation of deshi sugar which is more than double the output of central factories. Albeit no accurate estimate can be made of the number of people employed in the sugar industry, it can be fairly said that the number is considerable and important to national economy. *Thus, in its both agricultural and industrial aspect the importance of Indian sugar Industry is great.*

No wonder therefore that such an important industry has peculiar problems of its own, particularly because of its recent expansion in the factory manufacture of white sugar. In the pages that follow an attempt will be made to analyse these peculiar problems and limitations and outline the schemes for future course of action.

PRESENT POSITION OF SUGAR INDUSTRY.

We shall now proceed to analyse the present position of the Indian sugar industry after having discussed its importance to national economy. Notwithstanding the general trade depression, the sugar industry in India has expanded so rapidly during the last few years that it has surpassed the most sanguine expectations and in many quarters serious doubt is being felt regarding the development being lasting. For instance, in the year 1929-30 there were only about 30 cane factories and 12 refineries but for the season 1933-34, as the Sugar Technologist pointed out, there will be 128. This is not all. New factories are still being constructed, so that the total number of sugar mills seems to have increased to 145, as noted by Mr. M. P. Gandhi in the book.¹ The output of factory white sugar, therefore, has recorded a marked increase, as can be seen from the following figures² :—

Year	Production from cane.	
	Tons.	
1928-29	68,050	31,038
1929-30	89,768	21,150
1930-31	119,859	31,791
1931-32	158,581	69,539
1932-33	290,177	91,000

But the increase in the production of white sugar has not been confined to organised factories alone ; there has been an all-round development. The shrewd and alert indigenous producers as well have taken advantage of the situation and increased their output.

(1) Vide, *The Indian Sugar Industry*, Appendix III.

(2) Vide, *Sugar Technologist's Letter*, No. 7539.

The total annual production of white sugar which was estimated to be about 2 lakhs of tons up to 1930-31, increased to 2.5 lakhs of tons in 1931-32 and 2.75 lakhs in 1932-33. Thus, the total production of white sugar in India from both these sources has recorded a substantial increase during the last few years. Figures of the last five years tell their own story :—

Year	Total (Tons.)
1928-29	299,088
1929-30	310,918
1930-31	351,650
1931-32	478,120
1932-33	656,177

• The increase has been specially marked during the last two years. But the manufacture is being pushed ahead at a remarkable speed, so that according to the estimate of the Sugar Technologist the output during 1933-34 would rise to 8.86 lakhs tons and in 1934-35 to 9.46 lakhs tons. This means that the home production of sugar will exceed the present home consumption. According to Mr. Gandhi the actual output would be higher than the aforesaid estimate of the Sugar Technologist. He points out that the cane crushing capacity of factories is very much greater than that assumed by the Sugar Technologist, the number of factories started has been larger than calculated by him, the production due to the increase in the capacity of old factories has also been greater than the 10 per cent. assumed by him (during the year 1932-33, 18.4 per cent. more sugar was produced by old factories, as compared with 1931-32), and the duration of crushing season has also been greater. He further adds that the estimate of the Sugar Technologist has gone far wrong even for 1932-33 and will turn out still more incorrect in 1933-34 and 1934-35 as a result of the large extensions in plants, and the large number of mills with over 600 tons daily cane-crushing capacity, the extension of the duration of the season, the probable increase in recovery of sugar due to the efficiency of the machinery built according to the latest scientific advancement, to the availability of larger supplier of improved cane, and to the increase in the number of factories projected for working in 1934-35.¹ Therefore, according to his estimate the total production of sugar in India will be 11 lakh tons in 1933-34 and 11.5 lakh tons in 1934-35. This estimate does not come as a surprise. Albeit Mr. Gandhi has rather over-estimated the production, the actual output during 1934-35 will considerably exceed the estimate of 9.46 lakh tons. This fact has been conceded by the

(1) Vide, *The Indian Sugar Industry*, p. 58-59.

Sugar Technologist as well.¹ All these facts clearly bring out the most rapid growth of the industry for which the Indian industrialists can rightly feel proud.

This rapid progress in the development of the industry is due to several causes of which the State protection is by far the most important. On the representation of the Imperial Council of Agricultural Research, the Government of India referred the case of Sugar industry to the Tariff Board for enquiry. The Tariff Board in 1931, recommended a grant of protection to the industry for a period of 15 years and proposed that the protective duty on import of sugar should be fixed at Rs. 7-4-0 cwt. for the seven years and Rs. 6-4-0 per cwt. for the remaining eight years. The recommendations of the Tariff Board were accepted by the Government of India and therefore the import duty on sugar which was raised to Rs. 7-4-0 per cwt. in 1931 for revenue purposes was stabilised as a protective measure for a period of seven years by the Sugar Industry Protection Act of 1932. Thus, revenue considerations have played no less an important part in the present scheme of protection. In fact the Protection Act has helped the industry not by increasing the duty but rather by assuring the maintenance of the rate of duty at this figure for a definite period.

The financial requirements of the Government of India gave an additional impetus to the growth of sugar industry, because in September, 1932, a revenue surcharge of 25 per cent. was imposed on all import duties. This raised the import duty on Sugar by Rs. 1-13-0, from Rs. 7-4-0 to Rs. 9-1-0.

Another factor which raised the incidence of protection was the giving up of gold standard by England in September, 1932. The guilder being still on the gold basis, this placed a further handicap of about 20 per cent. on Java sugar coming into India.

Finally, the general economic depression has also had its share in helping the growth of sugar industry. As adverted to in the preceding section, sugarcane crop in comparison with other crops gives better return to the grower and provides the money which he needs for paying his revenue and other dues. Sugarcane cultivation has therefore steadily increased during the last five years from 2.65 million acres in 1928-29 to 3.41 million acres in 1932-33, as will be seen from the figures submitted below :—

(1) Vide, *The Times of India Commercial Supplement*.

Year.	Arta (Acres).
1928-29	2,650,000
1929-30	2,677,000
1930-31	2,902,000
1931-32	3,076,000
1932-33	3,409,000

During the same period the yield of cane has increased from 30 million tons to 50 million tons, the proportionately larger increase in yield being due to the increasing cultivation of cane of improved varieties. Improvement in the quantity as well as the quality of sugarcane and the prevailing low prices for gur have helped the sugar manufacturers considerably. Lack of organisation and concerted action on the part of cane growers has further helped the factory owners. Whereas the abnormally low prices of gur have helped the refineries which were struggling for their existence in 1929-30, the substantial fall in the price of cane leaves greater margin of profit to the factories. The factories located in the sugarcane belt in Northern India generally pay about 5 annas per maund for their cane supplies as against 8 annas paid three years ago. In some cases prices paid have been as low as 3 annas 6 pies per maund.

The cumulative effect of all the factors mentioned above has been an increase in the normal margin of profit of sugar factories to much above the figure of 10 per cent. which was regarded as fair by the Tariff Board. No wonder, therefore, if the sugar factories were built up with remarkable rapidity. The Sugar Technologist has rightly sounded a note of warning. He says "the rate at which the sugar industry has been developing during the last two years has recently become too fast to be healthy. In view of the statistical position disclosed above, considerable caution and restraint are necessary in connection with any further extension of the industry if it is to be saved the fate of jute, rubber and a number of other industries which are now suffering from the ill-effects of over-production."¹ This rapid multiplication in the number of sugar factories recorded in the recent years is not a true index of the intrinsic strength of the industry because there are a number of factories which can hardly stand the test of the competitions, which is an essential pre-requisite of sound industrial growth. New problems have arisen as a result of this rapid growth which demand an immediate solution before the industry can be well established in a state of stable equilibrium. Future progress apart, even if the present position of the industry and such development as has already taken place is to endure, it should be com-

(1) Vide, *The Sugar Trade Review*, 1931-32.

pletely re-organised and the inefficient appendage weeded out before the fiscal protection is withdrawn or reduced.

THE PROBLEM AHEAD

One important defect in the direction in which recent development has taken place relates to the selection of sites for some of the new factories. There has been an excessive development of the industry in the United Provinces and in Behar and niggardly development in the others. Particularly the northern part of Behar and the eastern districts of the United Provinces which were already overcrowded with factories, have attracted a large proportion of new factories and there are a few instances in which two new factories have been built at one station.

This defective location of factories has been due mostly to lack of foresight. There is no question that these congested areas possess a number of advantages at present. Thus there is ample area under cane cultivation and the cane growers are not accustomed to gur making to the same extent as in other cane growing areas. They understand the system under which factories purchased cane and are therefore willing and eager to sell their cane in preference to turning it into gur. There is also no indigenous Khandsari industry to compete for cane supplies. Trained labour for work in the factories is also plentiful.

Most of these advantages are, however, either temporary or are such as can, with little organisation, be secured in other and less congested areas also. As against these, the principal disadvantages, namely, that of overcrowding is likely to have a permanent effect. At present sugarcane is one of the few crops which give a fair return to the grower. When normal agricultural conditions return, sugarcane may not be able to maintain this privileged position and the area under cane cultivation may diminish proportionately to that under other crops in these localities. The factories will then have to go further afield for their supplies of raw material and the cost of cane delivered at the factory as well as loss and deterioration due to dryage in transit, will increase.

It should be pointed out, however, that the tendency to build factories in the already congested areas has now practically stopped. Most of the new projects are for the central and western parts of the United Provinces which, in addition to having plentiful supply of excellent cane and being practically free from competition from other factories, enjoy an advantage in freight on sugar to the most profitable markets in India, namely, the Punjab, Central India and Rajputana. South Behar is another important locality awaiting development. As pointed out by the Government of Behar and Orissa

in the course of a Resolution on the Annual Report for 1931-32 of the Director of Industries of that province, "As many as seven new sugar factories are reported to be under construction in North Behar and one or two are under contemplation in South Behar where the cane area is larger and has the advantage of irrigation. There is wide scope for indigenous enterprise to start sugar factories in South Behar, but it is a matter for regret that both indigenous capital and indigenous enterprise have so far failed to take advantage of the opportunities offered." Similarly, other provinces like Bombay, Punjab and Bengal afford ample scope for the establishment of sugar factories, and it is a relief to note that these areas have also attracted the attention of the capitalists and factories have been projected. But it cannot be gainsaid that in the United Provinces and Behar there has been an excessive development which has given rise to the problems of cane supply and marketing of white sugar which await solution.

Another retrograde feature of the industry has been the lack of adequate improvement alike in the quality of cane and the quality of sugar manufactured by the factories. Although the case for protection of the industry was based on agricultural grounds no legislative provision was made ensuring that the cane grower would receive his due share of the benefits of protection in the form of a fair price of cane as a spur to efficiency. Similarly, there was no assurance that any portion of the large manufacturing profits earned under the protective scheme would be utilized for agricultural development which may improve the cultivation of cane or raise the technical efficiency of factories. Fortunately the Government of India has realised the importance of this problem and the recent imposition of the excise duty on sugar the receipts from which would be partly utilized for the agricultural development of the industry is a move on the right lines. The Provincial Governments have also moved in the matter and measures are being taken for fixing minimum price for cane so that the factory owners may not take unfair advantage of the cane growers.

As a result of steep fall in the price of cane, many factories, amongst which are included some of the oldest and best managed concerns, have preferred to crush more cane, even though the percentage recovery of sugar is thereby reduced, as this gives large aggregate profit. If this tendency continues, it will inevitably lead to general lowering of efficiency, which if it goes too far, may eventually reduce the industry to such a condition that it would be entirely unfit for facing open competition when protection is removed or reduced.

There has also been a marked decline in the quality of Indian-made sugar during the last two years. Moreover, there is no uni-

formity of standardisation of quality at present. It would considerably facilitate forward business as well as trading in distant markets, if recognised standard samples could be fixed for sugar of the various grades generally manufactured by the factories. It should not be a difficult matter to prepare standards similar to "Dutch standard" used in Java. This would facilitate the marketing arrangements as well and eliminate the waste in transport costs resulting from internal competition and overlapping of marketing area.

Further, the tendency to crush more cane even at a lower percentage recovery of sugar, and the larger aggregate production of white sugar as a result of general expansion of the industry has added to the output of inferior grade of sugar. These inferior grades of sugar turned out by the factories, the so-called second or third quality, will be more and more difficult to sell in the future, specially on account of severe competition from Khandesari sugar. Therefore the production of these needs be curtailed or given up.

In the matter of sales of sugar the present arrangements, specially in the case of many of the new factories, leave a great deal to be desired. Those new concerns which started with new capital hoping to find the working capital and to pay the instalments due to suppliers of machinery, out of profits—and there are many coming in this category—cannot command sufficient finance to hold stocks when this may be necessary. Such weak holders demoralise the market and make it difficult even for others to secure a fair price.

There is also no uniformity in the form of sugar sales contract adopted by different factories, and the terms are generally such that forward business is made difficult. A standard form of contract, which may be fair to buyers as well as sellers, drawn up by, and carrying the authority of, a representative association or chamber of commerce would greatly help sugar business.

Storage accommodation for sugar at factories is another important matter which has not received the attention it deserves. The new factories are not the only offenders in this respect. Owing to considerably larger production many of the old factories also have insufficient warehousing space now. This deficiency not only makes it difficult to carry stocks to suit market requirements but also leads to deterioration of sugar if bags are stacked too high. The design, as distinct from the capacity, of sugar godowns is also an important factor in preventing deterioration, the points to be kept in view being a floor which will keep perfectly dry all the year round and the arrangements of ventilation in such a way as to prevent sudden changes either of temperature or of humidity.

Most of the shortcomings mentioned here are the result of inexperience. A great number of capitalists who have entered the sugar industry during the last two or three years have had no connection with it before. In the case of many recently formed joint stock sugar companies the directorate has not been quite appropriate. Unless the board of directors includes experienced financiers, technologists and men acquainted with the commercial aspects of the industry, it must fail to do justice to its responsibilities and the company must needs depend on others for guidance in managing its affairs in a proper manner.

The problem of marketing sugar and the consequent cost of transport is also important. The recent growth of sugar factories has brought this problem to the fore. With the increase in the number of factories and their clustering within a particular area the competition *inter se* of the sugar factories in marketing their output has considerably increased. This internecine competition involves waste in transport costs in addition to lower prices. Therefore the re-organisation of marketing arrangements is essential and should immediately be taken up if the industry is to maintain its present position.

The lowering of the cost of production is by far the most important problem before the industry if it is to stand the open competition of its rivals. For this, improvements should be effected both in the field and in the factory. Agricultural aspect is often overlooked because India has not yet realised that sugar is produced primarily in the field and not in the factory. Reduction in the cost of production can be effected by improvements in quality of cane so as to yield a bigger percentage of sugar and to extend the manufacturing season from 120 to about 160 days, by growth of early ripening and late ripening varieties of canes, by researches for removing pests, and introduction of suitable varieties of cane with richer sucrose contents so as to increase the yield of crop per acre. Adequate and regular supply of rich canes is essential for progress of the industry. Problem of the factory is much less difficult than that of the field. By the selection of up-to-date machinery and efficient labour force aided by chemical and engineering research, substantial economies in cost of manufacture can be effected.

More economic utilisation of the by-products, like molasses and bagasse, is also necessary for reducing the cost of production. Suitable avenues for the disposal of molasses needs be explored because its production has increased so much that it fetches no price at all, whereas in 1929-30 it fetched about Rs. 1-8-0 per maund.

The problem of consumption is also urgent. Since the pre-war years world sugar production has increased more rapidly than world

population. This comparatively rapid rate of increase of production has made the study of consumption problems in the case of sugar particularly urgent. The relative neglect of the consumption side has already reached its practical result in the need for schemes to restrict production, but the limitation of production has proved more difficult than its extension. Once again the science and the practice of human organisation as involved in the control of production, have proved more backward than the physical sciences that have made possible the advance in physical productiveness. Hence the need for a comprehensive study of the problem of consumption. In India too, the stage of over-production relative to the present demand has almost reached, as pointed out by the Sugar Technologist. But Indian industry need have no occasion for despair because the scope for increase in consumption is wider in India than anywhere else. In 1930-31 per capita consumption of sugar in India was 22.2 lbs. as against 108.5 in United Kingdom, 119.3 in Denmark, 61.7 in Belgium, 98.5 in Switzerland and 55.6 in Germany.

Thus, from the foregoing review of the present position of the industry it will be seen that although the sugar industry in India has been built up with remarkable rapidity it has still so many weak points that it cannot be regarded as being well established or in a state of stable equilibrium. The future of the industry, therefore, seems to be most uncertain. Further expansion apart, even if such development as has already taken place is to endure, the industry should be rationalised. The Sugar Technologist has aptly remarked that the Indian sugar manufacturers "cannot yet afford to rest on their laurels. The much more arduous task of stabilising and systematising the industry still awaits their serious attention. Not till such times as the industry on its agricultural, technical and commercial sides, has been completely rationalised and brought into line with competing foreign sugar producing countries, can they relax in their efforts."¹ In the pages that follow we shall attempt a critical analysis of these limitations of sugar manufacture and suggest the lines on which rationalisation should be effected.

AGRICULTURAL POSITION.

In the preceding section we have portrayed in broad outline some of the more important limitations of cane sugar manufacture in India. We shall now attempt a critical analysis of the production of sugarcane because the price of sugarcane is the most important item in the cost of producing white sugar amounting to approximately two-thirds of the total cost of manufacture. Sugar manufacturers in Java right-

(1) Vide, *Sugar Trade Review*, 1931-32.

ly say : " We make sugar in our field, not in our factories ". India, as we have already pointed out, has not yet realised that sugar is produced primarily in the field and not in the factory. It is due to this fact that the Indian industrialists have in recent years, particularly since the introduction of the protectionists régime, concentrated their attention and resources primarily on the factory side of the cane sugar manufacture to the utter neglect of the field. But for the commendable results of the Imperial Council of Agricultural Research there would have been very little improvement in the culture of sugarcane. Here, however, it should be pointed out that European capitalists have paid better attention to the improvements of sugarcane cultivation than their Indian confrères, as can be readily seen from the farms under the control of sugar factories owned and managed by them. Illiterate and debt-ridden Indian cultivators can hardly be expected to make any substantial improvement of their own accord and initiative in this direction, as it involves the question of finance, unless the financiers themselves come to their help and aid them on right lines. The progress in the cultivation of improved varieties of cane recorded in the recent years, thanks to the activities of the Imperial Council of Agricultural Research and the Provincial Departments of Agriculture, amply justifies this statement, and if only the financiers had shown slightly better interest, the supply of cane to the factories would have been far more economic and a sounder basis for our industry would have been laid. Efficient agricultural technique is the very basis of sugar production, right from the planting of the best breeds of cane to the timely, reliable and sufficient supply of these canes to the factory. Therefore we shall now proceed to examine the development of cane cultivation in different provinces.

SYSTEM OF CULTIVATION IN THE UNITED PROVINCES

The United Provinces furnish more than half of the total acreage under cane in India. This was so even when the Sugar Committee investigated the question for then the area was about 50 per cent. and at present it is about 52 per cent., as compared with 14.6 per cent. in the Punjab, 9.9 per cent. in Behar and Orissa, 7.2 per cent. in Bengal, 3.6 per cent. in Madras and 3.3 per cent. in Bombay. Thus, the United Provinces is by far the most important cane growing tract in India. It lies between 23°52' and 30°18' North Latitude and so falls entirely outside the tropics. Most of the rainfall is between the third week of June and September and in addition some thunderstorms in spring and occasional drizzles in winter when frost also occurs. After the monsoon, the sky is generally clear with bright sunshine followed by dry hot winds from about the middle of April until the advent of the monsoon. The soils are mainly of the alluvial

kind. "Even the soils classed locally as clays and stiff loams are found on analysis to contain a considerable proportion of what are conventionally known as coarse sand and fine sand. The great bulk of the alluvium contains adequate quantities of lime and potash but is deficient in phosphoric acid, whilst the amount of nitrogen present at any one time is small. The classification of soils recognised by the agricultural community is sand, loam and clay. These, it need hardly be stated, vary greatly in quality, but speaking generally, the loam soils of the United Provinces are excellent soils for cane."¹

In this province sugar cane is popular and is grown annually in rotation with other crops. Here it needs be noted that the technique of agriculture is primitive and entail considerable waste. Plant crops are usually sown and ratooning is rarely resorted to except in Gorakhpur division. There is no fixed system of rotation in any district, each cultivator growing the crop, he thinks most suitable and lucrative but the common practice is to plant on the same plot every fourth or fifth year. The period for which a field is permitted to remain fallow differs in different localities, one year's fallow being the practice in Gorakhpur and Rohilkhand Divisions which are the two most important cane growing tracts and produce greater part of the total cane turned out in the province, while in other parts a period of only six months is taken as sufficient after a Khariff crop. But the important feature to note is that fallowing is rarely dispensed with in toto.

The cultivation of cane may conveniently be studied in two main sub-divisions : the cultivation of thin and medium varieties and that of thick canes. This, because of the technique in the two cases, widely differs. It has already been pointed out that the technique of agriculture is generally poor in our country due primarily to the poverty and illiteracy of our agricultural population. The poor cultivator has no means to get improved implements and so he plods along with primitive ones handed down to him from his remote ancestors. Due to lack of education, in most cases they hardly doubt the utility and the efficacy of their method and the lower yield at the harvest time is generally attributed to the misfortune of the individual cultivator. Thus, the lack of proper general education and particularly that of modern improvements in agricultural technique coupled with the inadequate provision for financing these operations breeds the spirit of fatalism and thereby helps to lower the general standard of cultivation.

Notwithstanding these serious handicaps the cane growers have kept up a fairly good standard of cultivation and give prompt res-

(1) Vide, H. H. Ghosh, "*Sugar in India*, pp. 96-97.

ponse to improvements brought to their knowledge. For the cultivation of thin and medium varieties, he prepares the field laboriously. When a full year's fallow is allowed, he irrigates the field thoroughly and ploughs it frequently throughout the year. When, however, the fallow is limited to six months the number of ploughings is reduced. When the field is ready the sets are obtained by purchase in the neighbourhood or taken out from the farmer's own stock of the previous crop. No attempt is made at selecting them further than the rejection of sets obviously diseased. The methods of planting also differ. At some places cane tops are planted while at others whole canes are planted. Where entire canes are used they are left standing in the field after harvest until they are required ; but when tops only are used they are collected at harvest time, tied up in bundles, covered with a layer of moist earth and kept like that until the sowing season.

Manuring is generally cheap and simple. Farm Yard refuse and village sweepings are used as manures. The bulk of such manure is scattered over the entire field and is ploughed in. Oil-cake manures, as has been pointed out by Mr. Ghosh, are seldom used while green manuring and concentrated artificials are virtually unknown.¹

In growing thick varieties of canes, a more advanced system of culture is adopted. Fields are more adequately ploughed and before planting the ground is dug down about a foot so as to get a good seed bed as well as to destroy white ants and other insects apt to cause damage to the plants. The sets are sown in trenches two or three feet apart and are immediately irrigated after being covered with earth. The crop is heavily manured. In short, the whole system is one of specialised agriculture and has apparently been imported into the United Provinces with the Paunda cane. It is absolutely dependent on water and manure and is therefore confined to localities where both are abundant.

As regards the area under improved varieties of cane, the United Provinces has recorded remarkable progress as will be seen from the figures tabulated below.

Area under improved varieties of cane.
(in thousand acres).

Year.	U.P.	Punjab.	Behar & Orissa.	Bengal.
1929-30	281	79	81	74
1930-31	514	70	70	100
1931-32	678	120	189	100
1932-33	1,189	179	236	125

(1) Vide, "*Sugar in India*," p. 101.

It has already been pointed out that the United Provinces possess more than half the acreage under cane in India and about three-fourth of this acreage is under improved varieties. This progress is due primarily to the work done at the Coimbatore Research Station for improving the quality of cane and for breeding new varieties. Moreover, the attention of the station has hitherto been centered primarily on producing improved canes suitable in the main for the United Provinces and Behar and Orissa known as the Sugar belt of India. The Report of the Director of Agriculture for 1931-32 calculates that though on a number of private farms the yield of the new varieties under careful management exceeds 1,000 maunds per acre, on a freshly planted field, allowing for various factors, 600 maunds may be taken as a safer average. As compared with the indigenous varieties yielding about 350 maunds per acre, the Coimbatore canes have a considerable advantage. Further, attempts are being made in this province to cultivate special kinds of cane of early and late ripening varieties with a view to extend the crushing season of the factories.

With the introduction of Coimbatore canes has widened the scope for introducing improvements profitably. But notwithstanding these new varieties, there is much room for new methods of culture and improved agricultural technique. That the methods followed by the cane growers are primitive and wasteful has been noted. He needs better training in the modern agricultural processes. For instance, the field should be more adequately prepared than at present. Ploughing should be deeper and thorough. The frequent shallow ploughing with the crude wooden plough merely scratches the soil and therefore it should be replaced by fewer ploughings with the more up-to-date modern plough. The more accepted practice of ratooning is cane, wheat, fodder, crop, gram, fallow and again cane. Cane should not follow cotton crop which greatly exhausts the soil. Better manuring will be more profitable. Irrigation facilities needs be improved.

THE SYSTEM IN THE PUNJAB

This Province is outside the tropics, but claims the largest area under sugarcane next to the United Provinces. The cultivation of cane is scattered throughout the Province but of all the districts Gurdaspur is most important. Climate puts a serious handicap on the development of sugar manufacture in this Province. The short monsoon period and the extremes of temperature are serious handicaps. Crushing season is short and the danger of frost is a menace to the growth of the industry. Of the total area under cane about half is irrigated by canals and the other half depends on wells, rivers and rainfall. For sowing whole canes are used as sets. The canes intend-

ed for sowing are buried when the signs of frost become manifest. This helps to secure better and quicker germination. In the mild cold weather these canes are left standing in the field until the end of the harvest and are cut as and when required for sowing. But if the frost occurs at the end of the cold weather it causes serious damage to the canes standing on the field. While planting the sets hardly any selection worth the name is made, for all that the cane grower looks to is that each set contains at least two buds. Where canal water is available the fields are merely flooded and no attempt is made to irrigate by furrows or to use the water as thriftily as possible, as is done when the land is irrigated from a well. This is so because the cultivator has to pay a uniform tax per acre of area irrigated annually with the canal water irrespective of the number of times a given field is irrigated or water is utilized. The cultivator needs be taught that this improper utilization of canal water is wasteful and against their interest.

Manuring is rather poor. Farm-yard refuse is the chief manure extensively utilised throughout the Province. Cattle-dung is generally used as fuel so that it is only the refuse which is utilised as a top dressing. For healthy growth of cane it is necessary that better manuring should be resorted to.

Since frost is serious menace to sugar cane in this Province, the practice of windrowing should be popularised because this practice has proved to be a most effective method of preserving cane during periods of frost. Windrowing consists in pulling up the canes and laying them on the ground in rows so that the tops of the last row will cover the butts of the preceding row. With the help of this process canes can be preserved for about a month without deterioration. But it has been said that even when it is kept for three months, the loss is very small compared with that which results when the cane is left standing during frost followed by rain and a rise in temperature. The method of clamping is also an effective protection against frost. In Europe this method is largely employed for preserving roots or potatoes, and in India, too, it has been found useful in preserving canes from frost. The experiments at Tarnab Farm have clearly demonstrated that cane may be preserved in clamps without suffering any visible injury. Frost destroys the butts of canes left standing in the fields. Therefore canes which would be used for sowing in March and April are taken out of the ground with roots, leaves and tops in tact about the end of November when the first touch of frost appears. Thereafter, these canes are placed parallel to each other in a pit specially dug for the purpose. This pit is covered with a layer of

earth about six inches deep. These protective methods needs be popularised.

THE SYSTEM IN BEHAR & ORISSA

In this Province cane cultivation is more popular in Behar, rather than Orissa. Most of the cane crop is concentrated in the districts of Saran, Shahabad and Gaya. The soil consists mostly of the older alluvium of the Gangetic plain, which is yellowish clay with frequent deposits of Calcium Carbonate. The special feature of this Province is that European planters who have erected their factories in Behar, follow a more specialised and advanced agricultural technique. These planters manufacture sugar direct from cane and therefore till lately Behar was the chief centre for the manufacture of sugar direct from cane in India. These planters apart, the ordinary cane grower here follows the same antiquated agricultural technique as their confrère in other parts of the country. There is hardly any regular method of rotation. Whole canes cut into sets are used as seeds and the worst corner of the standing crop is usually kept for that purpose. No examination of the sets, to reject the diseased ones, is made and the cultivator is satisfied if the sets have buds. Planters, on the contrary, have their estates on a higher plane for protection against floods and follow advanced agricultural methods. They have a definite system of rotation. Manure used is generally of high quality. After proper ploughing and irrigation, planting is done in furrows and sometimes in regular trenches. When the cane is well above the ground, thorough hoeing and weeding is carried out.

Thus, in Behar we find, on the one hand, European planters pursuing advanced agricultural methods, and on the other hand, the ordinary peasant sticking to his antiquated and wasteful methods. This anomalous state of affairs is due to the illiteracy and poverty of the Indian peasant.

THE SYSTEM IN BENGAL

In respect of acreage under cane Bengal now stands fourth among the different Provinces of India, though in the earlier part of the present century it occupied second position. This decline in the acreage under cane is due to the expansion of jute cultivation and increased water-logging which adversely affects the growth of cane. The rainfall is usually heavy in this Presidency and it submerges the low-lying tracts. These inundations are suitable for rice and jute, but cause considerable damage to cane cultivation.

Thus, the most important limitation to the cultivation of cane in Bengal is water-logging. Further, there is no established system of rotation. Manure is also only sparingly used.

THE SYSTEM IN MADRAS

The Madras Presidency lies entirely within the tropics and although the climate is very suitable for the growth of cane, the area under cane crop is small and scattered. Due to this scanty and scattered nature of cane cultivation and the diversity of local conditions under which it is grown, it is extremely difficult to review the different agricultural practices in vogue in this Presidency. Ratooning is not the common practice. Here it may be pointed out that the most important limitation to the extension of area under sugarcane is the preference given by the agriculturists to the paddy crop. For the extension of area under sugarcane, therefore, it is necessary that this preference for paddy crop and the shortage of irrigation facilities should be overcome. In short it may be stated that the most important limitation in the extension of cane sugar manufacture in this Presidency is the lack of adequate cane supplies to keep the factory working. A sugar factory located in this Presidency in order to secure its regular and continuous working will have to create its own cane supplies either by having its own farms or by subsidising the agriculturists.

THE SYSTEM IN BOMBAY

In this Presidency canes of a better quality and higher sucrose contents are produced, but the area under sugarcane crop being small and scattered it puts a serious limitation on the establishment of sugar factories. For the successful working of a factory it is necessary that it should be able to get an adequate and regular supply of fresh canes. This may be secured either by the factory growing its own canes or by procuring from the cultivators in the vicinity, as the economic conditions permit. In view of the local conditions prevailing in the Presidency the Deccan Canals Financial Improvement Committee (1932) held : "The position of a factory entirely dependent on the willingness of cultivators to sell cane would clearly be hopeless, since the cultivators have an alternative market (if not a very profitable one) in gul, while the factory cannot exist without cane. Consequently, even if the requisite supply were forthcoming, the cultivator would be in a position to demand the maximum price for cane and the whole of the factory's profits would be absorbed therein."¹ To this limitation should be added the higher cost of production of cane in this Presidency. According to the Tariff Board's estimate the cost of cane in Northern India is 4 to 5 annas per maund,² whereas the estimate submitted by the Department of Agriculture, Bombay Presi-

(1) Vide, *Report*, para. 35.

(2) Vide, *Tariff Board's Report*, para. 48.

dency, to the Tariff Board is about 11 annas per maund. The cost of growing cane as supplied by the Belapur Company to the Deccan Canals Financial Committee, is 8 annas per maund.¹ Thus, although, the cost of cane grown by the factory is lower than that of the Cultivator's cane, it is substantially higher as compared with the cost of cane in Northern India.

RAMSWARUP D. TIWARI.

(1) Vide, *Report, Appendix VIII*; also para. 38.

INDUSTRIAL FINANCE IN INDIA

The appointment of an Industrial Finance Committee by the United Provinces Government is indicative of the fact that the problem of industrial finance in India is still an important one.¹ The Banking Enquiry Committee of 1931, had examined the question of industrial finance, and with a view to increasing the financial facilities to industries had made certain important recommendations. But as usual the Report of the Committee has been shelved, and the financial difficulties of our industries remain the same. Matters have been made worse by the depression which has hit hard all our industries. Schemes of planned economy have also been proposed for India, but it is noticeable that in none of these schemes has an important place been given to the discussion of the important problem of industrial finance. In this article, therefore, an attempt is made to study the present system of industrial finance in India, and with a view to increasing the financial facilities to industries, suggestions have been made for the establishment of special financial institutions. At the same time, suggestions have been made whereby the existing financial agencies may be made to increase their assistance to industries. It may be pointed out that we have dealt mainly with the financing of the major or large-scale industries, but this must not be construed as indicating that the problem of the financing of the small or cottage industries is unimportant.

FINANCIAL REQUIREMENTS OF THE MAJOR INDUSTRIES

The major or large-scale industries require capital for three purposes, *viz.*, (1) to finance the fixed assets or the block, *i.e.*, for the purchase of land, erection of buildings, installation of the plant and machinery, etc., (2) to finance extensions and improvements, etc., and (3) to finance the current assets or working capital, *i.e.*, for the purchase of raw material, payment of wages, salaries, rents and commissions, and to meet other day-to-day expenses. The capital that is required to finance the block is long-term capital, that required for extensions and improvements partly long and partly medium-term, and that required for working capital, short-term capital.

FINANCING OF FIXED CAPITAL

The finance for fixed capital by the major or large-scale Indian

(1) The Committee which was presided over by Sir S. N. Pochkhanawalla has now submitted its Report.

industries is raised at present through (1) Share capital, (2) Managing Agents, and, (3) Public Deposits.

Share Capital :—

The financing of the block by share capital, that is, through the formation of joint-stock companies is very common in the West. There, on account of the existence of an organized capital market and special institutions like Investment Banks, Issue Houses, etc., it becomes easy to float joint-stock companies and successfully raise their share capital. But in India, the raising of capital by the formation of joint-stock companies is always difficult. This is due to the reason that in this country there is no organized capital market as such, and institutions like Investment Banks, Issue Houses, etc., of which we have spoken above and which so much help in the floatation of companies in the West, are absent. There are but two Stock Exchanges, and there are no stock exchange facilities in the mofussil whereby the investing public may invest in industrial securities. But what is most important is the fact that the ordinary investor in India does not prefer to invest in industrial shares due to the failure of industries in the past. It is therefore that the most important of our industries which were promoted by well known managing agents found it difficult to raise their capital through the issue of shares in this country and had some times to recourse to the London capital market.

Managing Agents as the suppliers of fixed capital :—

In the absence of a capital market in India, and also the absence of investment institutions like Issue Houses, Investment Banks, etc., the work of the promotion of companies, and the issue, and marketing of their shares has been taken up by the managing agents. The managing agents undertake the work of the promotion of industrial companies and use their influence to place the shares of these companies first amongst their friends and then amongst the public. In this way they help industries to raise their fixed capital. It must also be noted that if the shares of any company are not well received by the public, the managing agents themselves take up large blocks of these shares. Besides, the managing agents from their own resources supply the finance which may be required for the fixed capital of industries which may happen to be under their control.

Raising fixed capital through public deposits :—

Some of the industries like the Bombay and Ahmedabad cotton textile industry and the tea gardens of Bengal and Assam raise their fixed capital through public deposits, that is, by the acceptance of deposits direct from the public for fixed terms and at a fixed rate of

interest. The financial standing and credit of the managing agents of the industries concerned is an important factor in securing these deposits. The method of financing the block by public deposits has its own defects, but it must be pointed out that, under the present circumstances, it has its advantages as well. Indeed the method has become popular and successful with some of our important industries, principally the Ahmedabad cotton textile industry. At this centre the mill companies never raise the full amount of their block capital by share capital. In fact the share capital of the existing mills bears a very small proportion to the large amount of capital sunk in the block. The managing agents being interested as promoters of the mill companies naturally supply a large part of the capital required to finance the original block, and the rest is raised by public deposits. As these deposits are used to finance the fixed capital they are accepted for not less than a term of seven years.

Difficulties of Indian industries to raise fixed capital :—

That Indian industries experience great difficulties to raise their fixed capital has been the cause of general complaint, particularly before the various Commissions and Committees. It has been said that the deficiency in the block capital, which cannot be raised by share capital due to the reluctance of Indian investors to take up industrial securities, is made good only after the greatest difficulties. But for the assistance of the managing agents who have willingly provided the fixed capital, many of the most important of the Indian industries would not have existed to-day. What are the causes of these difficulties? We have already said that one of the causes is the reluctance of Indian investors to invest in industrial enterprises. Besides this, there are two other causes, *viz.*, (1) drawbacks in promotion, and (2) absence of a well organized capital market in India.

First, as regards drawbacks in promotion. It may be noted that in India there are no capable company promoters. The managing agents who take up the work of company promotion are not all men endowed with the technical and business knowledge that is so essential in company promotion. Most of them are financiers pure and simple, and some of them have a hand in commerce also. They never specialise in a particular line of industry, and this can be seen from the variety of industrial enterprises controlled by them. No wonder therefore that some of the new companies floated by some of the most well-known of these managing agents were failures. As both the managing agents and individual company promoters lack the technical and expert knowledge that is so essential, cases of individual companies being started without sufficient capital are very

common. Faulty calculations as regards the amount of capital required to finance the fixed capital are found in the West, but such things are very common in this country.

In the second place, as regards the absence of a capital market, we have already referred to the fact that in India there are no institutions like Issue Houses, Investment Banks, Investment Trusts, etc., to promote new companies and to underwrite and market their securities. Stock exchanges, which are only markets in issued securities, exist only in Bombay and Calcutta, and as both are well-known for their speculative tendencies investors are afraid to invest through them.

FINANCING OF EXTENSIONS AND IMPROVEMENTS

Every industrial concern after it has been established for some time will find that for its efficient working it will have to undertake the work of extension and improvement of its fixed assets. Old plant and machinery must either be repaired or replaced, old buildings must be pulled down and new ones erected in their stead. The capital which is required to finance extensions and improvements is partly long and partly medium-term. This aspect of the question of industrial finance has not been given sufficient attention by industrialists in India.

The capital for extensions and improvements may be raised by (1) re-investment of earnings, (2) issue of new securities, either shares or debentures, and (3) borrowing from banks.

As regards borrowing from banks it may be noted at the outset that Indian Banks as a rule do not undertake the provision of finance for extensions or expansions, etc. And this is not to be wondered at as they do not take any interest in the raising of even the initial capital of industries. Commercial banks as they are, they strictly confine themselves to the financing of trade, besides providing to a very little extent the working capital of industries.

Re-investment of earnings :—

Industries in the Western countries finance their expansion and extensions, etc., through reinvestment of their earnings. A judicious policy as regards the distribution of the earnings as between dividends and reserve account is always followed. From the reserve account, sums are set apart to meet the depreciation charges, that is, for the ultimate replacement of the fixed assets like plant, machinery, etc. But in India, barring a few exceptions, most of the industries fritter away their earnings in dividends and very little is carried to reserves. The case of the Bombay cotton mill industry will serve as an illustration. During the boom years following the declaration of

the War the mills made enormous profits, but these were all distributed as dividends, and very little of the earnings was carried to the reserve account nor was proper provision made for depreciation. It may be noted that dividends as high as 200 per cent. were paid by the Bombay mills, so huge were the profits made. Had these very mills followed the judicious policy of even carrying a very small percentage of their earnings to reserves, then to-day they would not have been faced with the problem of finding money for extensions, replacements, etc. It is very desirable that Indian industries should take a lesson from the unwise policy followed by the Bombay mills, and should set apart a fixed percentage of their profits to meet expressly the depreciation charges and other expenses. In this regard it is noteworthy that the British industries even in recent years in spite of their small earnings do not distribute the same in dividends, unless they have made proper provision in the reserve account.

Issue of Shares and Debentures :—

The method of financing expansion and improvements by the issue of new securities, either shares or debentures, has been claimed to be the best. There have been instances, e.g., in Bombay, where some of our industries have wisely carried out their extensions by the issues of shares. As regards debentures it may be noted that such issues are unpopular with the investing public in India. A few important industries no doubt did successfully float debenture issues, but their success was due to the Indian Princes who took large blocks of such debentures. The issue of debentures by industries has its own advantages, for debentures can always be floated at low rates of interest. But the fact is that in India, besides the reluctance of the investing public to take up debentures, industrial concerns find that the comparative cost which such issues involve is higher than in the case of share issues. It is not possible to float debentures for less than 7% interest. Further, additional expenses have to be borne, e.g., under writing commission or brokerage, and the heavy stamp duty.

Finance for extension and improvements from managing agents and public deposits.

As most of the industries do not raise the necessary finance for extensions and improvements by reinvestment of earnings or by the issue of additional securities, recourse is again made to the managing agents and public deposits. Schemes of extensions, betterments, etc., are undertaken by the managing agents themselves who provide the necessary finance or who use their influence to obtain it from outside. Besides, those industries which accept deposits from the public use

a part of these deposits to carry out the necessary improvements.

FINANCING OF WORKING CAPITAL

We next turn to the financing of the working capital of industries. The working capital may be raised in two ways, *viz.*, (1) without borrowing, *i.e.*, by re-investment of earnings or by issuing new securities, and (2) by borrowing. While the first method is very popular in the West, the second is more common in India.

Raising working capital without borrowing.

As we have said this is a popular method of raising working capital in the West. The British industries particularly have financed their working capital, as far as possible without borrowing, by re-investment of their earnings or by issuing securities, shares or debentures. There is no doubt that British industries to-day owe their present position to the wise policy that they have followed. But in India industries as a rule rely on borrowing only to meet their working capital. We have already seen that our industries do not follow a judicious policy in the distribution of their earnings. If the industries carry a substantial amount of their profits to the reserve account, they can thereby meet not only their capital requirement for extensions and improvements, but even their current expenses.

If it is not possible to re-invest the earnings an industry can still avoid borrowing and raise its working capital by issuing securities, that is, shares and debentures. It was the opinion of the Foreign Banking Experts that not only the block but the working capital as well of an industry should be furnished out of its own capital, *i.e.*, by the issue of shares. But as we have already noticed more than once it is difficult in India to successfully issue either shares or debentures. Consequently when the industries find it difficult to raise their initial fixed capital by issuing securities, it is not strange to find them resorting to borrowing to finance their working capital.

Raising working capital by borrowing.

The borrowing by Indian industries is mainly made from four sources : (1) managing agents, (2) public, in the form of acceptance of deposits, (3) indigenous bankers, moneylenders, and big financiers, and (4) commercial banks.

Borrowing from managing agents.

We have already referred to the part played by the managing agents as company promoters and as the suppliers of the fixed capital of industries. In addition to these two services, they perform a third and a very important one, *viz.*, provision of the working capital of industries. The finance which they supply is provided from their

own resources or else obtained from their friends and relatives. The managing agents, it must be noted, supply a substantial part of the working capital of most of our important industries. This will become evident from the following table which gives the various sources from which the finance of the Bombay and Ahmedabad cotton mill companies is drawn :—

	Bombay (Figures for 64 mills).		Ahmedabad (Figures for 56 mills).	
	Rs. (in lakhs)	Percentage of total finance.	Rs. (in lakhs.)	Percentage of total finance.
Amount loaned by Managing Agents	5,32	21	2,64	24
Amount of Public Deposits ...	2,73	11	4,26	39
Amount loaned by Banks ...	2,26	9	42	4
Amount of Share Capital ...	12,14	49	3,40	32
Amount of Deben- tures (1) ...	2,38	10	8	1

It will be seen from the above table that the managing agents supply in Bombay and Ahmedabad 21% and 24% of the total finance of the mills respectively. Their importance as financiers is certainly greater than that of banks. Not only in the Bombay Presidency do the industries draw a large part of their working capital from the managing agents but in Bengal also they do so. There the managing agents supply finance to such industries as jute, tea, engineering, coal, electric, light railways, etc.

The managing agents deserve due merits for the part they play in the provision of the working capital of our industries. There is no doubt that this part of their activity involves considerable risk and responsibility. It also weighs heavily on them in times of depression, when other sources of finance become dried up. Many a time they have incurred heavy losses as a result of their financing the industries under their control. But at the same time it must be

- (1) Made up of :—46 from Managing Agents, 53 from Banks, 139 from the Public.

noted that borrowing from managing agents has its own disadvantages. An industry which relies mainly on its managing agents for its finance is bound to meet with difficulties. It may quite be possible that at the very moment the industry requires finance the managing agents, 'due to certain causes, may not be able to supply the same. Besides, the managing agents use their surplus money in advancing to their concerns only as long as they find it profitable to do so. As soon as they find other forms of investment profitable, they withdraw the funds that they have advanced to their concerns, and so put the latter into difficulties. In any case, therefore, too much reliance on the managing agents by industries is risky. But under the present circumstances, due to the reluctance of our commercial banks to provide the necessary finance to industry, the latter must still depend upon the managing agents. •

Borrowing from the public in the form of acceptance of deposits.

The system of financing the working capital by deposits received direct from the public is very commonly followed by the Bombay and Ahmedabad cotton mills as well as by the tea gardens of Bengal. We have already noted before that these deposits are used to finance the fixed capital as well as extensions and improvements. But it must be pointed out that the deposits which are used to finance the fixed assets are accepted for not less than a period of 7 years; and the deposits which are used to finance the working capital are accepted for six months to one year. The interest paid on deposits by the Bombay and Ahmedabad mills, respectively, varies from $4\frac{1}{2}$ to $6\frac{1}{2}$ % and 5 to 6%. The rate naturally depends upon the willingness of the public to make deposits; sound concerns under well-known managing agents are able to attract deposits at low rates of interest. The importance of public deposits as a source of finance becomes evident by reference to the table we have given regarding the financing of the Bombay and Ahmedabad cotton mills. In Bombay, where it is said that the system is on the decline, 11% of the finance is obtained from the public deposits. But in Ahmedabad where the system is still vigorous, as much as 39% of the finance is obtained from these deposits.

It is claimed that the development of the Bombay and Ahmedabad cotton mill industry is due much to the system of public deposits. But as a source of finance, the deposit system has many defects. It is a very uncertain source of finance, and therefore has been compared by some to a fairweather friend. When times are good any amount of deposits are forthcoming from the public. But when a period of depression sets in these deposits are at once withdrawn. What is worst is, that they are withdrawn from unsound as

well as sound concerns, thereby putting the latter into great difficulties which their condition does not justify. There is no doubt now that the deposit system has become out of date and should be replaced by a better system. But under the present circumstances, just as in the case of the managing agents, in view of the present attitude of our banks towards industry, the system of public deposits must be kept up.

Borrowing from the indigenous bankers, moneylenders and big financiers.

The indigenous bankers and money-lenders play an important part in the financing of the small and cottage industries. But in some cases they supply finance to even some of the large-scale industries. It must, however, be mentioned that the industries which resort to the indigenous bankers and moneylenders are less well established and not under the control of managing agents of repute. Consequently for the finance which they obtain they have to pay a very high rate of interest. It may also be noted that even some of the most important of our national industries have been financially helped by the big financiers in cities like Bombay and Calcutta and by the Indian Princes.

Borrowing from commercial banks.

We now come to the fourth source, *viz.*, commercial banks. Indeed, in the West the Commercial banks play a very important part in financing the current requirements of industry. But in India most of the commercial banks confine their attention mainly to the financing of trade, and take very little interest in industrial financing. This becomes clear from the table regarding the financing of the Bombay and Ahmedabad cotton textile industry. While in Bombay the banks supply 9% of the total finance, in Ahmedabad they supply only 4%. But there can be no denying the fact that the Indian commercial banks do provide finance to industries, though to a limited extent. The statement is usually made, that the Indian banks in no way interest themselves in the financing of industries, but this statement is not correct. Of course the finance which the banks provide is only for working capital purposes, that is, for short term, usually from 6 months to one year. The Imperial Bank is debarred from advancing for more than six months, and the other banks have naturally followed suit.

The advances made by our commercial banks fall under three classes :—

(1) Advances against tangible and marketable security lodged and pledged with the banks.

(2) Advances against the personal credit of the borrower, with a second signature to the pro-note.

(3) Advances against the personal credit of the borrower only.

Most of the Indian banks' advances fall under the first two classes, and advances against the personal credit are not common. The most favourite method of advancing, however, is under the cash credit account. Under this method an account is opened by a borrower with a bank and a maximum amount of drawing power is allowed to the former. Whenever an advance is allowed to the borrower, it must be secured by the hypothecation of stocks. The system of cash credits has become popular both with the borrowers as well as with the banks. The borrowers pay interest on the actual amount of money drawn by them day to day out of the maximum allowed, and at the same time they can reduce their obligations whenever they wish. (In some cases, the borrowers have to pay interest on a maximum amount which is generally one-half of the maximum allowed to them, whether they avail themselves of their cash credits or not.) Just as the borrowers can reduce their obligations at any time, in the same manner the banks can curtail or withdraw their facilities whenever they wish to do so.

The present practice of our commercial banks as regards their grant of advances to industries is the cause of much criticism. It is said that the banks insist too much on full backing of tangible and easily realisable assets and take no account of the personal credit of the borrowers. Besides, no notice is taken of the valuable fixed assets that the borrowers are able to offer as security. It is also pointed out that when advances are made against personal credit with the guarantee of the managing agents, the banks, in addition, demand the hypothecation of stocks as a further security. And as regards hypothecation of stocks it is the general complaint by industrialists that the banks keep a high margin, for example 25 to 30 per cent. in case of raw materials and finished goods and 50 per cent. in case of stocks in process of manufacture. The fact is that in times of depression these high margins become oppressive. Further, as the value of the hypothecated stocks fall the banks demand additional security or curtail their advances. The absence of warehouses in India also entails much trouble and loss of money on the part of industrial concerns. The hypothecated goods have to be stored in the godowns or warehouses of the banks when they possess such. If otherwise, the goods are allowed to be stored in the godowns or warehouses of the borrowers under letters of hypothecation to the lending banks. Weekly statements have to be submitted to the banks in this case. In both the cases, that is, whether the goods are

stored in the godowns of the banks or in those of the borrowers, every time the latter need a supply of the hypothecated goods, they have to apply to the banks which depute clerks to do the work.

Another complaint is that the banks are too strict in demanding repayment of their advances. Following the leadership of the Imperial Bank, all the banks do not advance money for more than six months. Though renewals are granted after the expiry of the term, this is not always certain, and consequently the borrowing industrial concerns are kept in a state of suspense. There is also the complaint that the banks discriminate between their European and Indian clients. As most of the bank managers are Europeans they are better able to come in contact with the European clients and show greater partiality for them in the matter of advances. One such example of the treatment accorded to the European and Indian clients can be seen from the fact that in Calcutta when advances are made to the European concerns the banks do not demand the guarantee of the managing agents, but in Bombay when advances are made to the Indian concerns the guarantee of the managing agents is demanded and taken, in addition to the hypothecation of stocks.

To a certain extent the present practice of the commercial banks as regards the grant of advances to industrial concerns is justified by the fact that they have some difficulties to meet. Most of the banks are not equipped with technical and credit departments for valuing the assets of the borrowing concerns and for judging their standing and solvency. In England and the U.S.A. there are special agencies like Dun's, Scyd's and Bradstreet's, which collect usual information as regards the financial standing and credit of the borrowers. The information is available to the banks on payment. But in India there are no such agencies. The absence of the Policy of "One company, one bank" is another difficulty which the banks have to face. The industrial concerns do not confine their borrowing to only one bank but do so from different banks. Besides, the borrowers are very secretive as regards giving information which the banks may demand and hence the latter have to be very cautious.

Complaints of insufficiency of working capital.

We had already seen that Indian industries experience great difficulty in the raising of their fixed capital. And their difficulty to raise working capital is not less great. Indeed, the complaint is frequently heard that due to insufficiency of working capital, industries have to stop working and even go into liquidation. There is no doubt that the difficulty is due to the attitude of our banks who are reluctant to finance industry to any great extent. But part of the

blame should be borne by the industries themselves. Many of them do not make any provision in their original share capital for current finance, and rely mainly on borrowing. They rely too much on managing agents and public deposits. Both these sources are reliable when times are prosperous, but in times of depression they become untrustworthy.

NEED OF INSTITUTIONS TO SUPPLY LONG-TERM FINANCE TO INDUSTRY

Having seen how the present industries are financed we shall make a few suggestions whereby the existing financial facilities to industries may be increased. We shall first take up the supply of long term finance to industries, and in the next section the supply of working capital.

Industrial Banks.

The need for the establishment of Industrial Banks, ever since the Indian Industrial Commission submitted its Report, has been emphasized on all hands. Private efforts were made to start Industrial Banks with the object of financing industries but they never succeeded in attaining that object. The Tata Industrial Bank which was started on a big scale with the object of financing industries never attained that object, and had to content itself with commercial banking before it was amalgamated with the Central Bank of India. Some Industrial Banks do exist at present but they do commercial banking to a large extent, and provide very little financial assistance to industries. An Industrial Bank of the right type must therefore be started under State assistance. The establishment of such an institution has long been overdue, and with the assistance of the Government and the co-operation of the other commercial banks it will not be difficult to start one.

The principal reasons for the establishment of an Industrial Bank or Banks in India are as follows. The existing industries as we have seen experience great difficulties in the financing of their fixed or working capital. The chief reason why industries experience difficulty to raise their fixed capital is the reluctance of Indian investors to take up industrial securities. There is no scarcity of capital as such in India : this can be seen from the fact that Government loans are well received and well subscribed. Besides, the recent exports of gold must have put the people into possession of money. The Industrial Bank is therefore needed to act as an intermediary between the industries and the investors. It is also needed to impose confidence among the investing public in industrial enterprises, and persuading them to invest their capital in such ventures. Industries at present experience difficulties to carry out their exten-

sions and improvements, and the Industrial Bank is needed to supply the necessary finance for this purpose also. Lastly, on account of the reluctance of the Indian banks to finance the working capital of industries, the necessary finance is obtained at present from the managing agents or deposits from the public. Until, therefore, the banks give up their present practice and increase their financial facilities, the Industrial Bank is needed to supply the working capital of industries also.

The Industrial Bank must be started with a large paid-up capital. Government should take up at least half the share capital to instil confidence in the minds of the investing public. The rest of the share capital should be issued to the public and the banks if they wish to co-operate. The Bank's share capital should be supplemented by debentures and such issues can very well be taken up by the banks and the insurance companies.¹ Government should guarantee the interest on these debentures.

As regards the business of the Industrial Bank we have already indicated this to a little extent. In regard to new industrial concerns, the Bank may assist in the provision of the initial capital by taking up the share issue or even a part of the same before passing it on to the public. As regards existing industries the Industrial Bank can supply their fixed capital and any other long term capital requirements, *e.g.*, extensions and improvements, in the following manner. Pending the issue of securities, either shares or debentures, by these industries, the Bank can give them a direct loan to meet their requirements. Or if these industrial concerns have issued shares or debentures, the Industrial Bank can underwrite them and see that they are placed amongst the public. The Industrial Bank should also provide the working capital of industries on proper security. Block capital should be taken as proper security. And lastly, the most important business which the Industrial Bank should undertake is the re-organization of our industries. In order to put our industries on a more stable basis we need to re-organise them. In England, the Bank of England has taken the lead to bring back the industries of that country to prosperity. The Industrial Bank should take the lead in the finance of the re-organization and reconstruction of our industries.

If then an Industrial Bank with State assistance is established soon in India, as we have outlined above, the present financial diffi-

(1) The Law regarding trustee investments should be amended so as to enable insurance companies and trustees to invest in the Industrial Bank's debentures.

culties of the industries will be solved, and at the same time the industrial development of the country will be assured. Besides, we have no doubt that other Industrial Banks through private initiative will be established on the model of the Industrial Bank that we have suggested.

Investment Banks.

One of the chief defects of the Investment Market in India is the absence of Investment Banks. We have observed that the difficulties of Indian industries to raise long term capital is due not to the scarcity of capital as such but due to the absence of proper financial intermediaries which would bring together these industries and the investing public. One such intermediary, the establishment of which we have already suggested, is the Industrial Bank. But besides the Industrial Bank, financial intermediaries like Investment Banks should also be established through private initiative. Investment Banks play an important part in England and the U. S. A. The Investment Bank is a financial intermediary, in that industries needing long-term finance come to it for assistance, and at the same time investors who have surplus funds at hand come to it for advice as to the best kind of security to invest in. When an industrial concern needs assistance, the Bank carefully studies the situation and gives advice as to the basis on which the financing can best be done. The Bank may make an advance direct ; but usually the concern will be advised to make an issue of securities. The Bank will decide the proper time when the issue should be made and also the kind of security to be issued that is, whether preference or ordinary shares, or debentures. The Bank will then underwrite the issue and place it before the public. Sometimes when an industrial concern has already made an issue, the Bank with its influence will help the concern to distribute the securities among the public. The most important service of the Investment Bank is that of a business adviser both to the industrial concern and the investor. The Investment Bank keeps in close touch with the concern that it has already helped. The Bank will recommend the favourable period when the concern can undertake expansions and improvements and how the financing can be done. As regards the investor, the Bank gives him advice in which security to invest and will later on protect him against loss.

There are many advantages if Investment Banks are started in India. These institutions can take up the work of the issuing and marketing of the securities of industrial concerns which is at present done by the managing agents. The managing agents at present

combine both the functions of promotion and investment banking. In view of the fact that the abolition of the managing agency system is urged, the managing agents should convert themselves into Investment Banks, supplementing their resources by share capital and thus enabling the public also to become partners with them. Of course, Investment Banks of the American type especially should be started as early as possible.

Investment Trusts.

During the last few years institutions known as Investment Trusts have been playing a great part in England and the U.S.A. in mobilizing the small savings of the investors and investing the same in safe and reliable forms of investment. In India the investors, in the absence of proper financial intermediaries to give them advice, are at a disadvantage so far as investment in industrial securities is concerned. We have suggested the establishment of an Industrial Bank and Investment Banks mainly with the object of bringing together industrial borrowers and investors. But there is one difficulty. The investors who are now scattered over a wide area and who have very small surplus sums to spare, are not effectively able to invest them in such investments as would give the maximum of returns with the minimum of risks. The establishment of Investment Trust would go a long way in solving this difficulty.

The Investment Trust is not an intermediary like the Industrial Bank or Investment Banks, but it is a kind of company formed by the investors themselves who subscribe to its shares and other securities. The funds thus collected are invested by the Trust in safe and reliable forms of investment. The management of the Trust is entrusted to experts who are conversant with business and financial matters. The manager is an experienced person, as he has to select the securities in which investment of the Trust's funds can be made. After selecting a particular security he recommends it to the Board of Directors which is composed of experienced businessmen and financiers. It may be noted that efficient management has become the first essential element in the successful working of the Investment Trust. Great care is taken by the management to see that the Trust's funds are invested according to some fixed principles. First, care is taken to see that all the "eggs are not put in one basket", that is to say, the Trust's funds are invested not in any one company but in as many companies as possible. Second, care is taken to see that, e.g., by the British Investment Trusts, that not more than 5% of their total funds is invested in any one company. Third, the funds are not invested in any one particular line

of industry, *eg.*, cotton, but are invested in a variety of industries, *eg.*, railways, iron and steel companies, electric companies, and so forth. And lastly, the Investment Trust follows the principle of geographical spread of its investment. As regards the distribution of the earnings of the Investment Trust a wise and cautious policy is followed. Not all the earnings are distributed in dividends, but substantial sums are carried to reserves.

From the above description of the Investment Trust it will become evident that if Investment Trusts are established in India the investors would stand to benefit much. At the same time industrial enterprises would also gain as the funds of these Trusts would be available to them. It may be noted that in India only one attempt at starting an Investment Trust has recently been made, *viz.*, the Industrial Investment Trust, Limited. This Trust has been started by well-known businessmen and it is working successfully. We have no doubt that other Investment Trusts will soon be established, but care should be taken to see that the par value of the shares of these Trusts is kept low, *viz.*, Rs. 10, so that these shares may be within reach of even the smallest investor.

Stock Exchanges.

At present there are only two well organized stock exchanges in Bombay and Calcutta. There are absolutely no stock exchange facilities in the interior with the result that a mofussil investor is not able to invest his surplus funds in any industrial enterprise. Stock exchanges play a useful part in directing the flow of capital to industrial undertakings by providing a market for the purchase and sale of securities. In the absence of stock exchanges in the mofussil, industrial enterprises find it difficult to raise their share capital. Stock exchanges should therefore be established in important industrial centres like Cawnpore, Nagpur, etc. Some sort of Government regulation of the stock exchanges is quite essential to put a stop to reckless speculation that is sometimes rampant on the Bombay and Calcutta Stock Exchanges.

SUGGESTIONS FOR IMPROVING PRESENT COMMERCIAL BANKING AID TO INDUSTRIES

So far we have dealt with the need for the establishment of institutions to finance the long term capital requirements of industries. When the Industrial Bank is established it will no doubt undertake the provision of the working capital of at least the important industries. But for the present the commercial banks can increase their financial facilities to industries, of course for working capital purposes, by improving their present practice. The commercial banks, if they are afraid to use their short term deposits in

industrial financing, should utilize their share capital only in this business, supplemented by the acceptance of deposits for fairly long terms.

The commercial banks without any great risk can take up debentures of industrial concerns that may be issued to raise the working capital, and after holding such issues for some time place them among the public. If the commercial banks show readiness in carrying out the above suggestion, the industries should give up their present methods of obtaining finance from the managing agents and public deposits.

Even in the matter of direct loans to industries that the commercial banks have at present been advancing, there is room for improvement. At present the banks insist only on the backing of liquid assets and take no account of block capital. The banks should try to give advances on the security of the block capital, of course always keeping a safe margin. Further, advances on personal credit are not common in India. The banks should lend on personal credit to the important industries which are of good standing and which are managed by managing agents of repute. Even if the banks do not for some time wish to take the risk of lending against the security of block capital or on personal credit, then the present hypothecation rule should be relaxed. The high margins demanded by the banks, which entail so much suffering on the part of industries in these days of depression, should be relaxed. Side by side with the relaxation of the hypothecation rule, there should be a relaxation of the six months' rule also. The banks should follow a more liberal policy as regards strictness of repayment of their loans and advances. Renewals should be granted to sound industrial concerns.

At present in India there is an absence of the policy of "one company, one bank". Part of the blame for the absence of this policy must be shared by the banks themselves who refuse to finance any single industrial concern to any great extent. The banks should therefore take a lead in this matter and develop this "one company, one bank" rule. The banks would be able to properly gauge the financial standing and credit of their clients if they open special credit departments on the American principle. With the help of these departments the banks would not find it difficult to follow the "one company, one bank" policy, as they would then know the true financial condition of every one of their clients.

FINANCING OF THE SMALL AND COTTAGE INDUSTRIES.

Thus far with the financing of the major or large scale industries. We shall now take up the financing of the small and cottage industries, *e.g.*, like hand-loom weaving, brass-ware, gold and silver

thread, bell-metal, carpet weaving, gur making, toy making, etc. It may be noted that these industries are carried on by artisans in the urban towns or in the villages as their principal occupation, or carried on by the agriculturists as an occupation subsidiary to agriculture.

Existing credit agencies.

The small and cottage industries require a very small amount of money to finance their fixed capital. Their fixed capital consists of the implements which they use in their trade, for example, tools, hammers, hand looms, charkhas, etc. Some of the cottage industries like basket making do not require any fixed capital at all. But all these industries require working capital for purchasing the raw materials, for meeting the day to day expenses, and for financing the marketing of the finished goods. The problem of the provision of working capital to these industries is an important one, and of late has arrested both official and non-official attention.

The system of financing of the small and cottage industries is not the same in all the industries. The principal existing credit agencies are : (1) the money-lender or the mahajan, (2) the merchant or dealer, (3) the Karkhandar, (4) the joint stock banks, (5) the co-operative societies and banks, and (6) the Government.

The money-lender or the mahajan plays a very important role in the financing of the cottage industries. Either in the urban or rural areas he takes an active interest in the provision of credit to the artisans. He is accessible at all times of the day, he requires very little of security, but the rate of interest charged by him is high. He makes advances both of cash or kind as the artisan may choose. In some cases the artisans have to sell to him their product at a price determined by him. The merchant or the dealer in raw materials or the products of the cottage industries is another important credit agency. He gives the raw materials to the artisans on credit, and in some cases, makes a stipulation that the finished product must be sold to him. A very high price is charged for the raw materials supplied on credit. Another important credit agency is the Karkhandar. The Karkhandar has his own workshop where the artisans have to work for him, or otherwise they work in their own homes. The Karkhandar supplies the raw materials which the artisans require. The Karkhandar puts his own capital in his trade, but sometimes he too relies on the money-lender or the big capitalist traders. The joint-stock banks do not play any part in the financing of the small and cottage industries. But the co-operative societies and banks have in recent years become an important credit

agencies. The artisans form themselves into either credit or non-credit societies. The credit societies are formed for supplying the necessary finance to the artisans, while the non-credit are formed for the purpose of purchasing the raw materials required by the artisans wholesale, or for the purpose of co-operative marketing of the manufactured product. The artisans' societies are financed by the Central Banks which exist in the important towns, and in their turn these Banks are financed by the Provincial co-operative Banks. And lastly, we must note that the Government especially in recent years has become another important credit agency, by providing credit facilities to some of the important cottage industries. Some provinces like Madras, Bihar and Orissa, Bengal and the Punjab have State Aid to Industries Acts under which funds are advanced to the deserving cottage industries.

Financial difficulties of the artisans.

The artisans who ply this or that small or cottage industry have many financial difficulties to face. As a general rule they are very poor; they have no savings of their own and always depend on the money-lender or the mahajan. The mahajan takes advantage of his position and always charges a very high rate of interest for their loans. He further stipulates that the finished product should be sold to him or else through him. The result is that the artisans are indebted for their life to him. The artisans also lack organisation and unity amongst themselves. They further meet great difficulty in the marketing of their products. As they have no resources to fall back upon, they are forced to sell their products at whatever price they fetch.

Co-operation for Small and Cottage industries.

Co-operation for the small and cottage industries seems to be the best remedy to solve their financial and other difficulties. Co-operation has already made much progress in India with regard to agriculture, but industrial co-operation has not made much progress. The need, therefore, for the extension of the co-operative principle to the small industrial workers must be emphasized. It is desirable that these co-operative societies should have as their object not only the provision of credit, but also the provision of facilities for the purchase of the raw materials which the artisans require, and the sale of the manufactured product.

Financial assistance by the State.

We have already seen that in recent years the State in India has given some measure of financial assistance to the small and cottage industries. It must however be noted that because of the importance

of these industries in our national economy they deserve much more of financial assistance from the State than they receive at present. And it is gratifying to note from the speech of Sir James Grigg in introducing the Budget for 1935-36 that the Government has decided to set aside a sum of Rs. 1 crore from its balances for the improvement of the cottage industries and the uplift of the rural areas. Financial assistance by the State should be given either directly or best through the co-operative societies formed by the artisans themselves. The Government should encourage therefore the formation of co-operative societies by the artisans. The Government should also help, financially or otherwise, in the establishment of such industries like weaving, basket making, lace making, etc., by the agriculturists as subsidiary occupations. We have no doubt that with proper financial assistance by the Government the small and cottage industries which are now in a decadent condition will prosper once more.

M. A. MULKY.

THE PARSIS OF BOMBAY AND PARSI 'CHARITIES'

The postwar years in world history have been years in which events have followed one another with feverish rapidity, giving rise to anxiety on the part of all those who look ahead and who are concerned in the future of humanity. Western civilisation seems to-day to be drifting towards economic chaos. The collective reason of mankind seems to confess to a sense of bankruptcy, when it becomes increasingly incapable of common planning to avoid the disasters of war and revolution, which are inevitably involved in the year to year unemployment of 25 to 30 million souls, not to mention an equal number if not a larger number of unemployed in the east. War and revolution are also involved in a policy of national selfishness that expresses itself in tariff walls and in increasing armaments and preparation for organised murder. In these postwar years all our old ideas and ideals handed down to us by our predecessors from the last century have been increasingly challenged both in theory and practice. In the midst of plenty we have to-day poverty on an unprecedented scale. International trade, the life blood of our economic system, is dwindling into a tiny trickle at a time when the wireless and the radio, the oilship and the aeroplane are linking this vast globe into a closeknit unit. Free thought and free speech, the achievement of a hundred years' struggle for the establishment of democratic institutions, have been ruthlessly suppressed, whilst the victory of Fascism is hailed as the result of the failure of Democracy in solving the problems that face the world. We, in the east, with our traditional conservatism and disinclination to change are slowly awakening to a consciousness of these changes. Whilst the West rightly or wrongly, is talking in terms of the failure of Democratic institutions as they exist to-day, we in the East look forward with hopefulness to an imitation of these institutions in our own country for the solving of our national destiny. Whilst the West is challenging the very foundations of the present economic order, and talking in terms of planning with a view to the development of all its actual and potential resources, and the organisation of production for use and not for profit, we in the East continue to speak in terms of the sanctity of property rights, of the value of individual enterprise, and of free competition.

* "Parsi Charity Relief and Communal Amelioration" by Dr. J. F. Balsara.

Capitalism, which seems to make its last fight for the conservation of its political power and influence by its alliance with Fascism in the West, is evidently in the first flush of youth in India, reminding us of the hopes and promises of the early years of industrial development in the West:

Nowhere does this contrast between the East and the West in the social and economic spheres present such fruitful material for observation and study as in the small community of Parsis living in Bombay. We have here a community with substantial resources in the shape of charitable endowments of all kinds, whose members have very rapidly taken to an indiscriminate imitation of Western manners and modes of life, and many of the upper classes of which have an outlook very much like the outlook of Western aristocrats a hundred years ago. Whilst modern capitalism in the West pays a lip worship at any rate to the new tendencies of our times, when the disinherited classes are seeking to come into their own, the representatives of capital in this community who are mainly responsible for the administration of the charitable endowments placed in their hands resort, as we shall see, to a system of outdoor relief such as prevailed in England under the Poor Law Administration in the days of Malthus. The anxiety and the alarm which Malthus felt in his days, the well wishers of the Parsi community feel to-day, as an indiscriminate system of doles undermining the morale of the community seems to be at work on an increasing scale, adding from year to year to the number of those who are dependent on communal relief. If there existed any opportunity for a capitalist society to proclaim to the disillusioned world its ability to organise a social order embodying the principles of justice, and securing contented classes co-operating with one another on a basis of healthy and comfortable living, by wise planning of the resources at its command, such an opportunity seems to exist to-day in the Parsi community. There is nothing more tragic than the wastage of the resources at the disposal of the community and the neglect of the opportunities which such resources afford for wise and intelligent planning for the future welfare of the community.

The number of Parsis living to-day in the city of Bombay is 55,000. Till 1921 the numbers of the community remained fairly steady over a period of 30 to 40 years. But the community increased by 5,500 souls in the decade ending 1931. It is difficult to make any statement with regard to the distribution of income, and changes in this distribution of income during the last 50 years in the community. But one or two observations may be safely made on the subject. In the first 75 years of the last century our community made

rapid strides in its economic status and development, and consequently played a prominent part in the social and political life of the country. We were the first of the Indian Communities to take advantage of the opportunities which contact with the British people opened out to the country. We acted as intermediaries between the East India Company's employees and the Indians. We availed ourselves more readily than others of the educational facilities which were offered to us in missionary institutions and in the Government Schools and Colleges. Our adventurous and enterprising spirits ventured across the seas as traders and merchants in the further East, at a time when crossing the Blackwaters would have involved living death to the Hindoos. By our educational attainments in the earlier days we were able to occupy leading positions in the public services and the front rank in medicine, law and other professions. It has also to be remembered that in those earlier days our ways of living were simple, the cost of living was not so high, and our communal needs were few and could be easily satisfied by the resources at our disposal.

The number of our community increased from 13,000 in 1816 to 49,000 in 1864, much more perhaps through immigration from the outlying districts into the city than by the natural growth of the population resident in the city. The census of 1872 gave us 44,000 as the number of Parsis in the city ; in 1881 we were 49,000 ; in 1891 47,000 ; in 1901 46,000 ; in 1911 50,000 and 52,000 in 1921. Our numbers did not rapidly increase during 50 years ending 1911. Our general education and our enterprise enabled us to lead fairly comfortable lives as merchants and tradesmen, as employees in Government services and in private firms, and members of the professions. The joint family organisation which we shared in common with the other Indian communities enabled us to take care of our dependants, and the funds at the disposal of the Parsi Panchayat Trustees were sufficient to provide for the needs of those whom adversity left stranded and helpless. Whilst our affluence in those days of simple living enabled us to provide for the needs of our own dependants it also made possible the flow of charity far beyond the limits of our community, in grateful memories of the days when the country had given a kindly and hospitable shelter.

Very rapid changes have taken place, however, in the social and economic condition of the Parsis living in Bombay City during the last quarter of a century. The rapid rise in the cost of living has seriously affected our community. Whilst prices have gone up, the average earnings of large numbers of the community have not correspondingly increased. As a rule wages do not rise in exact correspondence

with the rise in prices. But in our case there were further factors that were responsible for the bringing about of a serious situation. Numbers of our community have definitely abandoned the simpler modes of life to which they were once accustomed. There are some who regard the standard of comfort to which the Parsis have grown accustomed as an artificially high standard which is bound to affect unfavourably the general condition of the community. Our community has to recognise sooner or later the impossibility of maintaining an artificially high standard of living, more especially when we are surrounded by communities whose modes of life are simpler and whose social life is still based on the co-operative principles of the joint family system which we abandoned at a much earlier date. It is also to be remembered that the initial advantage which our community enjoyed in the earlier days of possessing a privileged position in the public services and in private firms as pioneers, and as having taken more rapidly to the educational opportunities which were offered to the country, the community is now gradually losing. In Government employment we no longer enjoy the preference which we once enjoyed due to our general attainments and to our professions of loyalty. In the professions likewise we can no longer hold the prominent position which we once held, when the other communities had not taken to education in such large numbers as they are now doing. There has been moreover between 1881 and 1931 a marked change in the nature of the occupational distribution of the Parsis living in Bombay city as indicated by the following comparative figures.

	1881	1921	1931
Tradesmen and Merchants ..	5318	2801	2901
Manufacturers ..	3697	1761	1615
Servants ..	2595	852	610
Sundry ..	13737*	....	....
Clerical ..	....	6626	5998

Unsatisfactory and inadequate as these figures are, they clearly indicate the drift, from an occupational point of view, from trade and industry to clerical work. It is a truism that a number of textile factories which were hitherto controlled by Parsis and which served to absorb a certain number of the community have now been sold or closed down. The men who have been employed in these factories and others employed in factories belonging to non-Parsis have now been thrown out of work. We estimate the number of families whose earning members have thus been thrown out of employment

* 22,579 women were returned under this head in addition to 13,737 men.

at between 500 and 1,000. We have no data which could enable us to ascertain the total extent of the unemployment prevalent in our community to-day. Mr. Markham in his report on the Parsi Community points out that between 1921 and 1931 the number of earning members of the community decreased from 18,000 to 17,000 whilst the number of the dependants increased from 34,000 to 40,000. Between 1931 and 1935 we have no hesitation in saying that unemployment must have increased by about a thousand. Markham on the basis of the figures of 1931 estimates the number of unemployed at 4,000. He adds to these 500 more as he believes there must be lads between the ages of 16 and 20 who have left school and are unemployed. Markham's estimate, therefore, of the number of unemployed in 1931 is 4,500. Between 1931 and 1934 the Parsi Charity Organisation Society arranged periodical doles for no less than 1,200 families which never asked for any doles in the preceding years. We seem therefore to be fairly correct in our estimate that between 1931 and 1934 about a thousand people have been thrown out of employment. Excluding boys and girls upto the age of 20 and males as well as females after 55, and further excluding women between 20 and 55 we find that about 17,400 people out of 57,700 may be regarded as the working part of our community. Out of these 5,500 are unemployed. If this estimate is correct, roughly 31 per cent. of the earning members of our community would seem to-day to be without a job.

With regard to the earning portion of our community it has also to be remembered that a fairly good number including families drawing incomes upto Rs. 150 to Rs. 200 p.m. live upto their income, with absolutely no margin in the shape of saving. The Insurance habit has not been extensively developed in our community. Provident funds of employees where they exist have been found to be drawn upon wherever such facilities are available. It may be said without exaggeration that more than 25 per cent. of the earning families live upon the margin, and the slightest cause that involves a diminution in the earning capacities of these families, like illness or accident, is sufficient to throw back the family upon doles received from charity funds. No attempt has so far been made to analyse the budgets of middle class families in the community. It would not be, however, far from the mark to say that at least about 25% of the income goes towards rent and that much of the work like cooking, laundry work, and other household duties, which in the other communities is done by members of the family, is done in our community by hired servants. Further the education of children in middle class families is an increasing burden on their resources as

they are sent to private schools where the fees charged are relatively higher than in Municipal and Government Institutions.

When we pass from the general economic condition of the Parsi community in the city of Bombay to-day to a consideration of the condition under which the submerged section of the community live, we have some more reliable data available to us, on the one hand from the records of the Parsi Charity Organisation Society, and on the other hand from an analysis of the records of the Parsi Panchayat funds given to us in a book recently published by the Joint Secretary of the Funds in question, Dr. J. F. Bulsara and entitled "Parsi Charity Relief and Communal Amelioration." From a table that Dr. Bulsara has supplied it appears that the number of fresh applications for help that the Panchayat funds received increased from 8 in 1876 to 84 in 1896, 101 in 1916, 393 in 1931 and 512 in 1933. "In the span of last 63 years from 1871 to 1933 there has been a steady increase, without any appreciable diminution at any time, both in the number of recipients of charity and the amount of relief given them," from the funds at the disposal of the Panchayat Trustees. In 1924 the number of people who received relief in Bombay from the Panchayat funds was 1052, nearly five times that of 1884, and the amount of relief was Rs. 78,000 or about 9 times that of 1884. In 1933 the number of those who received help from the Panchayat Funds was roughly 2,200 and the amount of help distributed between them was Rs. 1,93,000. From the figures made available from the records of the Charity Organisation Society it appears that in 1934, the Charity Organisation Society alone was instrumental in renewing help and in arranging fresh help in various forms in 1,420 cases. But there are a large number of cases in which the various charities arrange periodic doles on their own initiative without a reference to the Society. It is impossible, therefore, to determine the number of individuals and families that receive help from funds in our community in one form or another with any attempt at accuracy. We have further found that the total amount spent by various charity funds in our community in the shape of doles was Rs. 4,00,000 in 1934. This figure we have ascertained as the result of a circular letter sent round to the various charity funds in our community by the Charity Organisation Society. About five funds refrained from replying to the inquiry. Assuming that these five funds are spending about Rs. 25,000 per year in doles between them, we may say that the community spent Rs. 4,25,000 last year in periodic doles alone. Besides doles the community spent Rs. 1,45,000 through charity funds in the provision of school and college fees as well as books and maintenance charges in hostels for its boys and girls. One has to re-

member that in addition to the money spent in this way from charity funds for educational purposes our community has provided two educational institutions, namely, the J. J. Parsi Benevolent Institution, and the Byramjee Jijibhai Institution, where all Parsi children are admitted free of charge. We have further two orphanages, one for boys and the other for girls, each making a provision for about 200 students.

Of the two thousand and two hundred families in receipt of doles there may be more than 150 families with earning adult members whose income of Rs. 50 to 60 has to be supplemented by doles. The average size of the families in such cases is 5 to 6 members. The rest of the families and individuals who receive doles have an income below Rs. 50 p.m. This is borne out by the statistics given to us by Dr. Bulsara in his recent book. Dr. Bulsara's analysis is based upon the records of the Parsi Panchayat funds whose trustees have recently built up a central register of all recipients of doles with the co-operation of many of the charity funds that give doles. The following abstract is obtained from Dr. Bulsara's book :

No. of families whose income is nil.	104
No. of families whose income is below Rs. 10. p.m.	1,178
No. of families whose income is between Rs. 10 and Rs. 25 p.m.	521
No. of families whose income is above Rs. 25 p.m.	50

In the classes that receive help from charity funds we have repeatedly found that the earning capacity of the men and women does not exceed Rs. 30 p.m. The men in such classes work as cooks, hawkers, sellers of sandalwood, tally clerks and *chasniwallas* (carriers of consecrated food from fire temples to clients of the priests). The women work as cooks or sempstresses doing sewing and embroidery work and sometimes menial work. Assuming the total number of families to be 2,500 roughly and the amount spent in doles Rs. 4,25,000, we find that the average amount of doles per family works out at Rs. 170 to Rs. 180 per year or Rs. 15 p.m. Counting four souls to each family on an average the help given is Rs. 4 per head, per month. Taking Dr. Bulsara's estimate, namely, that there are about 1,300 families and individuals whose income is below Rs. 10 p.m. and assuming that of these 300 are single individuals it would appear that at least in 1,000 families with an average of two to three children, *i.e.*, four souls each, the total income including help amounts to Rs. 26 at the maximum. Deducting an average of Rs. 5 p.m. for rent a thousand families in the community to-day live on an income of Rs. 5 per head, per month, *i.e.*, definitely on a starvation level. Dr. Bulsara arrives at the same conclusion from his

own figures. Even taking into account, says Dr. Bulsara, supplemental earnings from casual work and occasional help from relatives, "we cannot but wonder how those families whose per capita monthly income is shown as Rs. 7 or less may be subsisting on such a starvation allowance."

One might naturally expect that in a community so well known for its enlightenment, and where education has permeated the large mass of the community, those who were responsible for the administration of the Charity funds and who were spending in doles alone a sum of Rs. 4,25,000 might have endeavoured to bring about a co-ordinated policy and worked together on a co-operative basis. The only attempt at securing co-operation between the various charity funds has been the one made by the Charity Organisation Society, which has now been in existence for 15 years. But the lack of co-operation may be gauged from the simple fact that in 1934 out of the total amount of Rs. 4,25,000 spent in doles only, Rs. 1,40,000 came under the observation of the society.* In other words, after about 15 years of hard work in securing co-operation between charity funds the society succeeded in achieving this result in 33% of the total amount of the doles. Last year alone Rs. 2,85,000 were distributed as doles without any attempt at co-operation on the part of charity funds. Apart from the charity funds that give relief there are a number of private individuals who help destitute Parsis in the shape of regular doles or casual relief ; and it is impossible to ascertain the amount of money that goes out in the form of charity, of which the inevitable result can be the increase of pauperisation and the multiplication of beggars. In a community that often prides itself on the extent and farsightedness of its charities, there are to-day a good many trustees of charity funds, and a larger number of fortunate individuals, who have money to give and who spend their resources in the honest belief that to respond spontaneously to a call for help is the surest method of obtaining the favours of the Gods and establishing a claim for a place in heaven.

We are glad to find Dr. Bulsara, the Joint Secretary of the Parsi Panchayat funds, giving us the result of his few years' experience in almost identical terms. "To-day we have the extraordinary spectacle in the city of Bombay with a total Parsi population of 57,765 only, about 7,000 or 8,000 of whom are affected by

* It has been said that this is exaggerated, as some Charity Funds do not give doles periodically renewable. The Parsi Panchayat Funds in some cases fix the doles for periods of two to three years. But the amount involved is a negligible quantity.

charity relief, of not a dozen or a score of charity funds, but about 65 large or small known funds or trusts, and about a score of known individual donors. And these are vying with one another to solve without success the stubborn problem of Parsi poverty by giving help in cash and kind to about 2,000 families, with until recently, a complete and successful isolation from one another." "With this spectacular public philanthropy in which larger donors have taken the lead, we find any Parsi man or woman or group of them, who so wish, trying to establish a charity fund or institution, and either giving monthly help or immediate relief according to their whim, often without any reliable records of their selfless work. Charitably inclined individual Parsi men and women supplement their unique effort with their own gifts and distributions to those who go about from door to door and office to office begging for alms, in face of the established and known channels of relief where any Parsi can apply and get help according to his or her deserts."

For the last two decades the question of co-operation between charity funds for the simple purpose of avoiding wastage and overlapping of help has been constantly before the community. We have had agitation about the urgency of this question carried on in the press and from the platform. Every year the Charity Organisation Society has added its pathetic cry about the extent to which the community has been demoralising in increasing numbers by the lack of co-operation between charity funds, which compel parties requiring help to go from fund to fund for the purpose. In a recent meeting of people connected with charities which was called at the Taj Mahal Hotel, a large majority of the representatives of charity funds who were present joined in a chorus of protest and indignation against the lack of co-ordination of work between bodies that were distributing doles. And yet we are afraid what is happening in Europe to-day on a larger scale in the matter of armaments is happening on a small scale in our community in the matter of co-ordination of work between charities. In Europe during the last decade we have been hearing from day to day indignant protests against the folly of armaments. Public meetings have been held, articles have appeared in the papers, and international conferences have deliberated on the necessity of coming to an agreement about the reduction of armaments. And all the time some of the people who have taken part in these deliberations are busy planning expenditure on the weapons of warfare in the name of national safety. So also in our community much has been said in the press and in public meetings about the necessity of co-operation between charity funds. Conferences have been held like the one held at the Taj Mahal

Hotel, where representatives of charity funds have solemnly shaken their heads about the disastrous results of lack of co-ordination. And yet all the time some of these very people may have been consciously or unconsciously contributing to these very results by indiscriminate granting of relief to applicants for help. Whilst in theory they admit the desirability of co-operation, in practice many of them act on the belief that such co-operation involves a direct encroachment on their privileges and duties of distributing the patronage that the endowments at their disposal confer upon them.¹

The Trustees of the Parsi Panchayat funds distribute nearly 2 lacs of rupees every year in the shape of relief. The trustees of these funds are doing selfless work in the general interests of the community and possess the confidence of the community to a remarkable degree. Some of them have recently been very forward in endorsing the need for co-ordination of work between charities. And yet the following illustrations that we are able to give with regard to their methods of work may serve to indicate the extent to which pauperisation may be helped by the granting of inadequate relief which forces the recipients to go from door to door and from fund to fund.*

Case No. 1. Husband, wife and eight children, seven small and schooling, husband in a tuberculous sanatorium. Rent Rs. 13, one girl earning Rs. 20 p.m. The Panchayat trustees were advised to give Rs. 30 p.m. They did this for a year, then reduced it to Rs. 25. This was done at a time when the rent was increased from Rs. 13 to Rs. 23 p.m. The trustees either thought that Rs. 22

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1. Cf. *Minority Report on Poor Laws*, Vol. III, (1909): "And whilst there is only one Poor Law Authority in each Union, there are often, besides uncounted individual donors, dozens of separate charitable agencies—in large towns hundreds, and in the Metropolis nearly 2,000—each spending its income without any relation at all to the spending of its neighbours, guiding its policy solely with a view to its own individual interest, neither knowing or caring, as a rule, what is done by any other agency, and almost inevitably creating extensive overlapping with its consequent waste and demoralisation." Our solace is that we are not the only sinners in this respect.

* These cases are chosen at random from a larger number; and if we have selected cases illustrating the administrative methods of the Trustees of the Panchayat Funds it is because they can by a public appeal to the community attract funds to the full extent of their requirements. Doles are a crude method of helping in any case, but doles, given sparingly, and calculated to drive families to further appeals for help, are worse as methods of relief. But the methods of the Trustees of the Panchayat Funds are representative of those of a large majority of their class.

p.m. were enough for nine souls, or they assumed that the party would go to other funds and supplement the help.

Case No. 2. Widow with five children all small. Not a pie of income. Stranded by the death of her husband and living in Widow Ashram. The Society advised the Panchayat trustees to give her Rs. 30 p.m. They sanctioned Rs. 20 p.m.

Case No. 3. Husband, wife and eight children. Husband 62 years old and unemployed for years. Two grown up sons, one of whom left the family and the other unemployed. Total earnings between two grown up daughters and the father Rs. 30 to 35 p.m. The Panchayat trustees were advised to sanction Rs. 30 p.m. They started with giving the amount, subsequently reduced the amount to Rs. 25, and now to Rs. 20. The condition of the family in the meantime has grown worse, the wife on account of her ailments being sent out of Bombay with two daughters.

It is not unnatural that parties who do not get enough to keep their children alive, should under these circumstances go from fund to fund and even from house to house for supplementing whatever they get from any one fund. All attempts at saving the self respect of families made by the Charity Organisation Society have thus been frustrated on account of a shortsighted policy such as is illustrated in the few typical cases that we have mentioned. Every charity fund in its policy of giving doles works on the assumption that as its funds are limited, it can only give part of the total relief which any particular party requires, and, therefore, expects these recipients of doles to go the whole round of various charities and private individuals charitably inclined, to make up for their requirements. Such a policy seems to reach the limit of absurdity when for example a fund spending about Rs. 75,000 a year is asked to give Rs. 25 for books required by a school-going child and sanctions Rs. 10, on the assumption that other funds will make up for the balance.

The same lack of co-operation and shortsighted policy of partial relief are to be found operating in other fields of charity. In addition to Rs. 4,25,000 spent last year in doles there were five associations and funds which spent roughly Rs. 30,000 in the shape of supplying grain to needy families. We believe, apart from those five funds, there are a number of other agencies and individuals who supply grain. There is no attempt at any kind of co-operation or co-ordination between these separate organisations. Each of them

supplies a quantity of grain that can last from four to six weeks, and thus offers direct inducements to the recipients to go from one organisation to another. The same thing occurs in the matter of help given to families who require recuperation of health in sanatoria outside Bombay. The parties who require help for such purposes get partial relief from one fund, and supplement it by applications to other funds. As applicants for doles or for help in other forms are not aware of the various funds that exist in the community they are helped in this campaign of begging by professional application writers who are familiar with the details of the sources from which help could be obtained. Recently it has come to the notice of the Charity Organisation Society that nearly 20% of the applications for help that are forwarded to it from charity funds for report, are written in the handwriting of one and the same party. In the matter of loans given to people who are anxious to run small trading or industrial ventures we have the same story of the lack of co-ordination. There are a number of organisations and private individuals who claim to do the same kind of work each in an isolated fashion, thus offering scope for duplication and overlapping of help. Mr. A wants a small sum of money for purchasing materials. He gets what he requires from one source. A few months later he makes an identical request to another fund or individual getting a similar amount ; and a few months later again the same story is repeated. Each of the individuals or funds helping knows nothing of what the others have done in the past. Mr. B applies to the Charity Organisation Society for a railway ticket to enable him to join service at a place out of Bombay. The Society purchases a ticket and sends him off. It is subsequently discovered that he has obtained a similar amount from one or two other sources which never cared to, or found it difficult to, inquire or to ask for a report from the society.

Dr. Bulsara seems to be fully alive to these unfortunate results that follow upon lack of co-operation of charity funds and their policy of giving inadequate help and compelling the applicants to go from fund to fund. The number of applicants on account of such a policy go on increasing, says Dr. Bulsara, "there are other developments peculiar to this shortsighted and unsupportable policy of giving deliberately inadequate relief—first, with regard to the giver, and, secondly, with regard to the recipient of charity." Men, observes Dr. Bulsara, under such a system either starve, incur ruinous debts or are obliged to apply again or elsewhere for some more assistance, much against their wishes and at a risk to their self respect. If the applicants are persons without a moral backbone, the smallness of the amount offers them a heaven-sent excuse to roam

about from fund to fund and door to door, sponging on charity and collecting as much as their ingenuity can procure.

There thus seems to be an ill devised arrangement in our community for encouraging systematic beggary. The policy or lack of policy on the part of those who are responsible for the administration of charity funds in our community effectively saps the morals of those who receive help. Instead of enabling them to retain their self respect our method of giving doles seems to be deliberately contrived to drive them into the streets as professional beggars, making them unfit for the future for serving their community in such ways as may be open to them. The life of the community is an organic whole in which the parts act and react on one another. We cannot do anything that contributes to the moral degradation of one class in our community without being prepared for seeing the reaction of that degradation on other classes. In the early days when society was based on the institution of slavery it was repeatedly pointed out that the moral degradation involved in the institution not only contributed to the dehumanising of the slaves but tended to dehumanise the masters as well. We are afraid that a society which by its system of charity relief contributes to the pauperisation of one section stands in danger of spiritually pauperising the donors and distributors of such charities as well. The Parsi community of the present day prefers to live in a backward age ; and some of the trustees of our charity funds sometimes take pride on the great good work that they are doing for the community in giving doles of Rs. 5 and Rs. 10 p.m. in a patronising spirit, helping half starved families to eke out a lingering existence. The mentality of the trustees is the mentality of the mid-Victorian capitalists who thought that they were conferring great benefits on the wage earners when they endeavoured to undo by a little welfare work the inevitable consequences of a policy of sweating and underpaying the labourers.

The prospects before the community in the immediate future seem to be very clouded. With the continuation of the depression, and with the increasing struggle for existence in a city like Bombay, where the unskilled members of our community accustomed to an artificially high standard have to face the competition of more skilful men belonging to other communities, we must be prepared to see the number of dependants on charity funds increasing in the years to come. The resources at the disposal of our community will continue to be taxed till they reach the limit. These resources are not inexhaustible. With greater co-ordination they could be economised, and a considerable amount of wastage might be prevented. But at present we are not only reconciled to a policy of wastage of these resources, but we seem

to live in the présent without taking any thought of the future. The poorer sections who are in receipt of doles are rapidly multiplying. Their children are usually ill fed, feeble in body and much more feeble in mind. It is exceedingly common to find in these classes half-witted boys and girls, whose education requires special treatment, but who have been allowed to vegetate in the lower standards of our educational institutions, till their parents are compelled to remove them,—only to throw them into the world to drag out an unemployed existence or to earn a miserable pittance supplemented by doles. These social misfits unable to maintain themselves, and with no sense of responsibility in the matter of increasing the size of their family, will become an increasing burden on the community. The boys and girls of these social misfits, when they grow up half-witted and weaklings, will be unable to earn a decent living for themselves; and with the help of doles will multiply the number of dependants in ever expanding circles. This seems to be the prospect facing the community in the future as the result of our present method of administering the charity funds at our disposal.

What are the measures that our community has thought of adopting in the face of these conditions? We have not as yet in our community any trained social workers who could be regular visitors in the slums, advising families about their needs and the needs of their children and following up from year to year the physical and mental development of these children. We have no facilities in the city for the proper training of such social workers. None of our charities have even dreamt so far of securing the services of trained social workers for meeting some of the needs for work of this kind in our community. The extent of unemployment in our community is further bound to increase on account of the more general causes that are connected with trade depression the whole world over. The adoption of a farsighted policy and planning would require a twofold series of measures; firstly an organised effort at supplementing the limited income of all classes of unemployed people, the help being graded according to the size of the family, irrespective of all other considerations based upon merit or desert; and secondly, careful planning for the children of such families providing for their health and educational needs. But even when all this is done, we do not think we shall see the end of poverty or unemployment; firstly because such unemployment is determined by causes which lie beyond the control of our community, and also because the social and economic environment in which the community is living, with differences in standard of comfort, with relative disparity in numbers, and with limited avenues of employment in a

country dependent on the mercies of foreign rulers, may frustrate the effects of all the careful planning that our community may resort to. No single community, even though it may be small in numbers and provided with material resources, can to-day live a separate and isolated existence. Its economic life will be determined by factors beyond its control. And whilst we need not be entirely pessimistic with regard to the future, we must be prepared to face the possibility of a frustration of all our well devised schemes in a world which is becoming increasingly unified, and where therefore we can only prosper together or fail together.

When all has been said and done, one has to acknowledge that our community in the matter of charity is at a stage of development which we may well call medieval. There are still a large number of individuals amongst us who believe that the giving of alms is a meritorious act. There are more who give because they are good hearted and simple minded, and who have their sympathies aroused by the apparent destitution of the mendicant, but who do not pause to consider the probable effects of their alms. And this attitude of mind is reflected even in some of the trustees of the charity funds that exist in the community. May we dedicate to all these the words which Tolstoi wrote a few years before his death ? :—

“It is as if I were sitting on the neck of a man, and having quite crushed him down, I compel him to carry me and assure myself and others that I am very sorry for him, and wish to ease his condition by every means in my power,—except by getting off his back.”

It was a realisation of the fact that indiscriminate alms-giving multiplies the number of paupers, and leads to a moral degradation of the giver as well as the recipient of the gift, that led in the West in the nineteenth century to the introduction of organised private relief based on discrimination. Scientific research and the application of statistical methods to the study of social phenomena led to an appreciation of the relatively greater importance of preventive measures. The charity organisation movement which started in London, in 1868, led to a prevention of duplication and deception, to careful investigation into the causes of destitution in individual cases, and to systematic friendly visiting. But the movement towards reform did not stop short with these vast benevolences of modern life which are too often an ostentatious return from secret cruelties. In a number of countries private relief work has to-day been overshadowed by state boards of control, and state boards of charities. Old age pensions, insurance against sickness and accident, and insurance against unemployment have taken over vast fields of work which were

hitherto mainly occupied by private philanthropic efforts. There is a small but growing section of humanity that objects to the use of the terms "poor houses" and "alms houses" and who resent departments of relief work being called departments of "public charities." They feel that public relief is the right of those who need it. They believe that the pauper is not to be regarded as one, who is being privileged to survive through the generosity of private individuals or of the state, but as one who owing to peculiarities of circumstance is receiving his support from society in this manner rather than as a wage earner or as an employee of the state. They hail the demise of the old conception of charity, and emphasise as part of a code of justice a social responsibility in terms of services which in the past have been withheld from the poor, or granted grudgingly through private charity. They would urge the need in the concept of charity of a more democratic philosophy of group life and a more genuine respect for individual personality.* They would assert that private and public charity should disappear, and the assistance provided through the agency of society should be regarded as one phase of the interdependence upon each other of the individuals who belong to the society.

If poverty is a pathological condition of society, statesmanship demands the reconstruction of our social institutions which would lead to the disappearance of poverty. Modern poverty far from abandoning its claims on the universe, with those meek who are to inherit the earth, struggles doggedly to wrest from an unwilling world the minimum necessary to animal existence. It breeds apathy and langour and restlessness, and stings the poor into rage where it does not crush them into listlessness. All attempts at the relief of poverty by public or private philanthropy must be regarded as ambulance work aiming not so much at the removal of the disease as at alleviating some of the incidental pain and misery. Dependency in human society is not likely to disappear and cannot disappear, so long as there are children and old people and the physically and the mentally unfit. What is normal dependency and what is abnormal will largely depend on the existing forms of social institutions. In a socialist organisation the rearing of children by their parents would legitimately

* Cf. for instance G. D. H. Cole "Principles of Economic Planning." Appendix to Ch. IX. Cf. also : "Many a secular philanthropist who prides himself upon his benevolence is unconsciously expressing his power in his benefactions and would be stricken with horror if a just and intelligent society reduced his privileges to terms consonant with his service to society, depriving him of the luxury of feeling unselfish while he selfishly maintains most of his essential privileges." Niebuhr : "Contribution of Religion to Social Work."

be regarded as a pathological condition ; and so also the dependence of women on male supporters. A social organisation that is reconciled to poverty as a normal feature and accompaniment of economic evolution, and which only admits of palliatives in the shape of philanthropy and welfare work, is itself a diseased condition whose removal may sometimes demand a radical surgical operation in the shape of revolution, as witnessed by the history of Russia during the last twenty years. May we hope that elsewhere the disease may be cured by patient persuasion and wise planning ?

Nowhere else to-day is there a more splendid opportunity for wise social and economic planning than in the Parsi community with its splendid resources. We are spending to-day Rs. 4,25,000 a year on doles, Rs. 1,45,000 on educational help, about Rs. 30,000 in the supply of grain to the needy. We have in addition three splendid educational institutions whose assets in property alone could be reckoned at about 60 lacs, and which have corresponding endowments for running them. We have in addition an orphanage for girls with accommodation for two hundred boarders. We have built up residential facilities in the shape of charity chawls for more than 750 families. We have immense landed property lying idle and unused in the hands of the Parsi Panchayat Trustees round about the towers of silence. With the help of all these resources it would be possible not only to provide for a comfortable existence for all who are unable or unfit for work, but to plan out educational institutions for all the younger generation of our community, giving them a new outlook on life, imparting to them a sense of the values of life which will enable them to seek first things first, and sending them out into the arena of life for a prosperous existence, equipped by a scientific training and yet capable of subordinating the material pursuit of comfort and wealth to the things of the spirit. If a Lycurgus could plan for ancient Sparta and even a Hitler for modern Germany, there is no reason for abandoning the hope that the Parsi community might have in its fold a future lawgiver who may do by his personal influence what scores of mediocre thinkers and reformers may fail to achieve. But if with all these material resources at our command we fail, the failure will be ours : for with all the chanting and singing and telling of our beads, we shall have shut ourselves in our own dark corners ; we shall have sacrificed the God of Humanity working and inviting our help as fellow workers with Him in the fulfilment of His increasing purpose to the vain pursuit of a God after our own image, delighting in incense and pampering our self-righteousness.

GENEALOGICAL STUDY OF SOME VITAL PROBLEMS OF POPULATION, PART II*

SECTION I.

AGE AT MARRIAGE

The following tables give the distribution of ages at marriage of man and woman in three generations : grandfather, father and the present generation.

A.—AGE OF WOMAN AT MARRIAGE

(i) GRANDFATHER-GENERATION

(1) *Frequency Table.*

Age at marriage.	Cases.
10	29
11	43
12	76
13	10

158

Average age :—11·42.

N.B.—All ages are to be understood as completed years. There are 8 cases of double marriage of men.

(ii) FATHER-GENERATION

(2) *Frequency Table.*

Age at marriage.	Cases.
10	2
11	17
12	182
13	291
14	272
15	172
16	59
17	7

1002*

Average age :—13·59.

* There are 34 cases of double marriage of men.

* This study is the second instalment, the first being published in the University Journal, Vol. II, Part IV, of January, 1934. It refers to the same class of people as those of the first instalment but it is based on a fresh sample. It will be seen that the averages of the two series of different items do not materially differ, especially in the trends.

(iii) PRESENT-GENERATION

(3) *Frequency Table.*

Age at marriage.	Cases.
11	1
12	8
13	74
14	334
15	453
16	205
17	44
18	2

1121*

Average Age :—14·81.

* There are 44 cases of double marriage of men.

AGE OF MAN AT MARRIAGE

(iv) GRANDFATHER-GENERATION

(4) *Frequency Table.*

Age at marriage.	Cases.	Age at marriage.	Cases.
11	2	20	13
12	4	21	3
13	4	22	5
14	15	23	3
15	10	24	2
16	15	25	3
17	27	26	2
18	27	27	2
19	12	29	1

116

34=150

Average age :—17·7.*

* In the 8 cases of more than one marriage only the age at the first marriage is considered.

(v) FATHER-GENERATION

(5) Frequency Table.

Age at Marriage.	Cases.	Age at Marriage.	Cases.
13	3	21	202
14	5	22	137
15	6	23	82
16	15	24	34
17	35	25	11
18	78	26	3
19	152	27	2
20	202	28	1
496		472=968*	

Average age :—20.4.

In the 34 cases of double marriage (i.e., second marriage) only the age at the first marriage is considered.

(vi) PRESENT-GENERATION

(6) Frequency Table.

Age at Marriage.	Cases.	Age at Marriage.	Cases.
16	1	23	204
17	5	24	81
18	22	25	21
19	55	26	4
20	169	27	1
21	233	28	...
22	280	29	...
...	...	30	1
765		312=1077	

Average age * :—21.6.

* In the 44 cases of more than one marriage only the age at the first marriage is considered.

From the above tables we find that the average age of woman at marriage in grandfather-generation was 11.4, in father-generation 13.5 and in the present generation it is 14.8.

While the average age of man at marriage in grandfather-generation was 17.7, in father-generation it was 20.4 and in the present generation it is 21.6.

Thus we see that the average age of woman and man at marriage is increasing, though it is far from the ideal.

SECTION II.

DIFFERENCE IN THE AGES OF COUPLES

The following tables give the distribution of the differences in the ages of couples in three generations.

DIFFERENCES IN THE AGES OF HUSBAND AND WIFE

(i) GRANDFATHER-GENERATION

(7) *Frequency Table.*

No. of years.	Cases.	No. of years.	Cases.
1	5	10	6
2	7	11	2
3	13	12	2
4	17	13	3
5	25	14	1
6	31	15	2
7	13	16	2
8	14	17	1
9	5	21	1
130		20=150	

Average difference :—6.2.*

* For the purposes of the above average the first marriages are taken into consideration.

(ii) FATHER-GENERATION

(8) *Frequency Table.*

No. of years.	Cases.	No. of years.	Cases.
1	3	7	332
2	11	8	222
3	11	9	48
4	20	10	7
5	78	11	2
6	231	12	2
...	...	13	1
354		614=968	

Average difference :—6.7.*

* For the purposes of the above average the first marriages are taken into consideration.

(iii) PRESENT-GENERATION
(9) *Frequency Table.*

No. of years.	Cases.	No. of years.	Cases.
1	...	8	282
2	1	9	56
3	4	10	6
4	24	11	2
5	87	12	1
6	251	13	...
7	361	14	1
...	...	15	1
728		349=1077	

Average difference * :—6·9.

* For the purposes of the above average the first marriages are taken into consideration.

It is seen from the above tables that there is a decided tendency for the difference in the ages of husband and wife to increase, which fact may properly be explained as being due to the fact that owing to the greater spread of education among the males their marriages take place at later ages while the same factor has not operated in favour of the postponement of marriage in the case of females, among whom the spread of education is rather slow.

SECTION III.

AGE AT THE BIRTH OF FIRST CHILD

The following tables give the distribution of the ages of man and woman at the birth of first child in three generations.

A.—AGE OF WOMAN AT THE BIRTH OF HER FIRST CHILD

(i) GRANDFATHER-GENERATION

(10) *Frequency Table.*

Age at the birth of first child.	Cases.	Age at the birth of first child.	Cases.
13	4	19	1
14	26	20	2
15	44	21	1
16	40	22	2
17	24	23	1
18	12	24	...
		25	1
150		8=158	

Average age :—15·89.

(ii) FATHER-GENERATION

(11) *Frequency Table.*

Age at the birth of first child.	Cases.	Age at the birth of first child.	Cases.
13	2	20	20
14	62	21	7
15	55	22	4
16	278	23	...
17	260	24	1
18	150	25	3
19	55	30	1
862		36=898	

Average age :—16.81.

(iii) PRESENT-GENERATION

(12) *Frequency Table.*

Age at the birth of first child.	Cases.	Age at the birth of first child.	Cases.
13	2	20	33
14	17	21	13
15	68	22	5
16	139	23	5
17	187	24	1
18	152	25	2
19	83	26	...
...	...	27	1
648		60=708	

Average age :—17.32.

B.—AGE OF MAN AT THE BIRTH OF HIS FIRST CHILD

(iv) GRANDFATHER-GENERATION

(13) *Frequency Table.*

Age at the birth of first child.	Cases.	Age at the birth of first child.	Cases.
16	3	26	7
17	6	27	3
18	13	28	2
19	13	29	3
20	19	30	2
21	21	31	3
22	21	32	2
23	14	33	...
24	9	34	1
25	6	38	1
...	...	40	1

125

25=150

Average age :—22·24.

(v) FATHER-GENERATION

(14) *Frequency Table.*

Age at the birth of first child.	Cases	Age at the birth of first child.	Cases.
16	1	26	69
17	5	27	35
18	7	28	12
19	21	29	2
20	45	30	5
21	81	31	1
22	146	32	1
23	200	33	2
24	195	34	...
25	139	35	1

840

128=968

Average age :—23·38.

(vi) PRESENT-GENERATION

(15) *Frequency Table.*

Age at the birth of first child.	Cases.	Age at the birth of first child.	Cases.
18	3	27	44
19	10	28	20
20	18	29	6
21	29	30	7
22	80	31	6
23	134	32	2
24	131	33	...
25	137	34	2
26	78	43	1
620		88=708	

Average age :—24·21.

From the above tables we find that the average age of woman at the birth of first child in grandfather-generation was 15·89, in father-generation 16·81 and in the present generation it is 17·32, while the average age of man at the birth of his first child in grandfather-generation was 22·14, in father-generation 23·38 and in the present generation 24·21.

Thus we see that the average age of woman at the birth of her first child and the average age of man at the birth of his first child have very slightly increased.

SECTION IV.

AGE AT THE BIRTH OF LAST CHILD

The following tables give the distribution of the ages of man and woman at the birth of last child in two generations :—Grandfather and father-generations.

A.—AGE OF WOMAN AT THE BIRTH OF HER LAST CHILD

(i) GRANDFATHER-GENERATION

(16) *Frequency Table.*

Age at the birth of last child.	Cases.	Age at the birth of last child.	Cases.
19	1	34	9
22	3	35	5
23	1	36	9
24	...	37	8
25	5	38	6
26	3	39	5
27	8	40	4
28	2	41	3
29	7	42	1
30	8	43	...
31	4	44	1
32	8	45	1
33	6	46	2
...	...	50	1
56		55=111	

Average age at the birth of last child :—33·18

(Only completed marriages are taken into consideration, *i.e.*, those marriages in which both the partners lived together till the woman reached the age of 40.)

(ii) FATHER-GENERATION

(17) *Frequency Table.*

Age at the birth of last child.	Cases.	Age at the birth of last child.	Cases.
21	2	35	44
22	2	36	46
23	5	37	28
24	7	38	19
25	16	39	10
26	8	40	10
27	9	41	11
28	12	42	2
29	12	43	2
30	12	44	1
31	16	45	...
32	14	46	2
33	36	47	...
34	32	48	...
...	...	49	1
...	...	50	1
...	...	51	...
...	...	52	...
...	...	53	...
...	...	54	1

183

178=361

Average age at the birth of last child :—33·62.
 (Only completed marriages are taken into account).

B.—AGE OF MAN AT THE BIRTH OF HIS LAST CHILD

(i) GRANDFATHER-GENERATION

(18) *Frequency Table.*

Age at the birth of last child.	Cases.	Age at the birth of last child.	Cases.
26	2	41	11
27	1	42	7
28	3	43	5
29	3	44	4
30	1	45	4
31	3	46	5
32	3	47	3
33	3	48	5
34	4	49	3
35	6	50	1
36	6	51	1
37	8	52	...
38	4	53	...
39	7	54	1
40	5	60	2

59

52=111

Average age at the birth of last child :—39·63.

(Only completed marriages are taken into account).

(ii) FATHER-GENERATION
(19) *Frequency Table.*

Age at the birth of last child.	Cases.	Age at the birth of last child.	Cases.
23	1	42	39
28	3	43	26
29	3	44	33
30	5	45	20
31	12	46	15
32	9	47	10
33	12	48	7
34	12	49	8
35	6	50	5
36	18	51	1
37	14	52	1
38	14	53	2
39	22	54	...
40	29	59	1
41	32	62	1

192

169=361

Average age at the birth of last child :—40·5.

(Only completed marriages are taken into account).

From tables (18) and (19) we find that the average age of woman at the birth of her last child in grandfather-generation was 33·18 and in father-generation 33·62.

The average age of man at the birth of his last child in grandfather-generation was 39·63 and in father-generation it was 40·5.

It will be seen from these figures that reproduction ceases far earlier than what is generally considered to be the physiological limit.

In order to test whether reproductive power had really come to an end at the time indicated by the above tables, the cases of completed marriages were further analysed with a view to determining if a sufficient number of years had elapsed after the birth of the last child during which the couples continued to be in a married state. It will be seen from the following tables presenting this analysis that in the grandfather-generation in the cases of completed marriages in which both the partners were alive for seven or more years after the

birth of the last child woman lived on an average for 21 and man for a little over 22 years. Similarly in father-generation woman lived for 13 years and man for nearly 13 years.

A.—AVERAGE NUMBER OF YEARS WHICH A WOMAN LIVED AFTER THE BIRTH OF HER LAST CHILD

(i) GRANDFATHER-GENERATION

(20) Frequency Table.

No. of years woman lived after the birth of last child.	Cases.	No. of years woman lived after the birth of last child.	Cases.	No. of years woman lived after the birth of last child.	Cases.
8	1	20	3	32	1
9	5	21	3	33	2
10	2	22	...	34	3
11	4	23	3	35	1
12	4	24	3	36	1
13	6	25	2	37	1
14	4	26	4	38	2
15	6	27	1	39	2
16	1	28	2	40	1
17	1	29	...	41	2
18	4	30	2	42	...
19	6	31	3	43	1
—	—	...	...	47	1
44		26		18=88	

Average number of years which a woman lived after the birth of her last child :—22.

(Only cases of completed marriages in which both partners lived for seven or more years after the birth of their last child are taken into account.)

(ii) FATHER-GENERATION

(21) Frequency Table.

No. of years woman lived after the birth of last child.	Cases.	No. of years woman lived after the birth of last child.	Cases.
7	19	20	6
8	36	21	4
9	22	22	3
10	34	23	7
11	27	24	3
12	23	25	2
13	17	26	2
14	16	27	2
15	15	28	1
16	10	29	...
17	12	30	2
18	6	31	2
19	8	36	1
245		35=280	

Average number of years which a woman lived after the birth of her last child :—13.11.

**B.—AVERAGE NUMBER OF YEARS WHICH A MAN LIVED
AFTER THE BIRTH OF HIS LAST CHILD**

(i) GRANDFATHER-GENERATION

(22) Frequency Table.

No. of years man lived after the birth of last child.	Cases.	No. of years man lived after the birth of last child.	Cases.	No. of years man lived after the birth of last child.	Cases.
8	2	22	3	37	2
9	8	23	6	38	...
10	4	24	2	39	2
11	1	25	2	40	2
12	2	26	2	41	...
13	2	27	3	42	...
14	3	28	3	43	...
15	2	29	1	44	...
16	...	30	2	45	...
17	5	31	3	46	1
18	3	32	...	47	1
19	1	33	1	48	...
20	5	34	1	49	...
21	4	35	3	50	...
...	...	36	5	51	1
42		37		9=88	

Average number of years a man lived after the birth of his
last child : 23·09.

(Only cases of completed marriages in which both partners lived for seven
or more years after the birth of their last child are taken into account.)

(ii) FATHER-GENERATION

(23) *Frequency Table.*

No. of years man lived after the birth of last child.	Cases.	No. of years man lived after the birth of last child.	Cases.
7	22	20	4
8	30	21	7
9	21	22	5
10	33	23	7
11	17	24	4
12	11	25	5
13	12	26	1
14	22	27	6
15	21	28	1
16	12	29	2
17	19	30	1
18	8	34	2
19	6	35	1

234

46=280

Average number of years which a man lived after the birth of his last child :—13.96.

(Only cases of completed marriages in which both the partners lived for seven or more years after the birth of the last child are taken into account.)

From tables 20-23 it becomes clear that the age at the birth of last child indicated in the tables Nos. 16, 17, 18, 19 do really mark the end of reproductive power.

In view of the fact that the end of reproduction occurs very early in the case of both man and woman a question arises as to whether this early cessation of reproduction is due to the exhaustion mainly of man or woman. To shed some more light on this problem thirty-four cases of double marriages in father-generation have been analysed. Being cases of second marriage none of them happens to be a completed marriage. It is found that the woman's age at the birth of her last child is 30.5 while the man's age is 43.73. It is further found that on an average 6.26 years have elapsed since

the birth of the last child. We may therefore reasonably assume that in these thirty-four cases also reproduction has nearly come to an end. It is seen that in this sample the woman's age at the birth of last child falls short of the age of woman at the birth of last child in general sample by little more than 3 years, while man's age in this sample is higher than man's age at the birth of last child in the general sample by 3 years more.

The following tables give the frequency distribution of 34 cases above referred to.

ANALYSIS OF THIRTY-FOUR CASES OF DOUBLE MARRIAGES
IN FATHER-GENERATION

(24) *Frequency Table.*

Age of man at the birth of his last child.	Cases.	Age of woman at the birth of her last child.	Cases.	No. of years both partners lived after the birth of their last child.	Cases.
29	1	19	1	1	1
30	1	21	1	2	3
36	1	22	1	3	8
37	3	23	1	4	2
39	1	24	2	5	4
40	2	26	2	6	2
41	3	27	1	7	4
42	3	28	3	8	2
43	3	29	2	9	1
44	2	30	1	10	2
46	2	31	2	11	...
48	1	32	3	12	...
49	5	33	2	13	2
50	2	34	2	14	2
51	1	35	4	15	1
52	1	36	4	...	...
53	1	37	1	...	...
55	1	40	1	...	...
34		34		34	

Average of thirty-four cases of second marriages where partners are living :—Age of man at the birth of his last child 43·73. Age of woman at the birth of her last child 30·5. The average elapsed since the birth of last child 6·26.

SECTION V.

FECUNDITY OF MARRIAGE

The following tables give the distribution of the fecundity of couples in two generations :—Grandfather and father-generations.

(Only completed marriages are taken into account).

AVERAGE FECUNDITY OF MARRIAGE

(i) GRANDFATHER-GENERATION

(25) *Frequency Table.*

No. of birth	No. of cases.	Cases of Twins.
1	...	
2	2	
3	10	
4	19	3
5	19	
6	26	3
7	26	
8	7	
9	1	
10	1	
111		6

Average fecundity :—5·56.

Only completed marriages are taken into account, *i.e.*, those marriages in which both the partners live together till the woman reaches the age of 40.

(ii) FATHER-GENERATION

(26) *Frequency Table.*

No. of births.	No. of Cases.	No. of Twins.
1	...	
2	14	
3	26	2
4	30	3
5	74	
6	112	
7	78	
8	17	2
9	7	
10	...	
11	1	
17	1	
19	1	
361		

Average fecundity :—5·7.

From the above tables we find that the average fecundity of marriage was 5.56 in the grandfather-generation and 5.7 in the father-generation.

SECTION VI.

INTERVAL BETWEEN TWO CONSECUTIVE BIRTHS

The following tables give the distribution of the intervals between two consecutive births : issues of the couples of three generations : grandfather, father and the present generation.

INTERVAL BETWEEN TWO CONSECUTIVE BIRTHS

(i) GRANDFATHER-GENERATION

(27) Frequency Table.

Interval in years between two consecutive births.	Cases.
1	1
2	39
3	228
4	246
5	102
6	16
7	4
8	...
9	2
10	1

639

Average interval between two consecutive births :—3.7.

(ii) FATHER-GENERATION

(28) Frequency Table.

Interval in years between two consecutive births.	Cases.
1	26
2	319
3	1541
4	1158
5	243
6	66
7	26
8	9
9	1
10	1
11	...
12	...
13	...
14	1

3391

Average interval between two consecutive births :—3.4.

(iii) PRESENT-GENERATION

(29) *Frequency Table.*

Interval in years between two consecutive births.	Cases.
1	11
2	196
3	267
4	167
5	42
6	6
7	2
8	1
9	1

693

Average interval between two consecutive births :—3·04.

From the above tables we find that the average interval between two consecutive births among issue of grandfather-generation was 3·7, among those of father-generation 3·4 and among those of the present generation 3·1.

SECTION VII.

CHILD MORTALITY

The following tables give the distribution of mortality among children born to couples of three generations :—Grandfather, father and the present generation.

Mortality among children under five years of age per 1,000 children born.

(1) *Grandfather-generation.*

Total No. of births	..	..	..	..	..	805
Miscarriages	..	..	..	..	..	15
Total No. of children born	..	..	..	..	..	790
No. of children dead under five years of age	:—177.*					

Rate of child mortality under five years of age per 1,000 children born :—224·05.

(2) *Father-generation.*

Total No. of births	..	..	..	..	..	4497
Miscarriages	..	..	..	..	..	141
Total No. of children born	..	..	..	..	..	4356
No. of children dead under five years of age	:—1006.					

* On page 300 of my first study there is a printer's error under this item.
No. of children dead is 184 and not 164.

Rate of child mortality under five years of age per 1000 children born :—230·94.

(3) *Present-generation.*

Total No. of births 1530

Miscarriages 106

Total No. of children born 1324

No. of children dead under five years of age :—348. Rate of child mortality under five years of age :—244·38.

From the above tables we find that the average mortality among children under five years of age, born to the couples of grandfather-generation was 224·05, among children born to the couples of father-generation 230·94 and that among children born to couples of the present-generation is 244·38.

Thus we see that child mortality has increased.

SECTION VIII.

The following tables give the distribution of the ages at death of man and woman in two generations; grandfather and father-generations.

A.—GRANDFATHER-GENERATION

(i) AGE OF WOMAN AT DEATH

(30) *Frequency Table.*

Age at death.	Cases.	Age at death.	Cases.	Age at death.	Cases.
14	1	34	1	54	3
16	2	35	1	55	2
19	1	36	1	56	1
20	1	37	3	57	1
22	1	38	2	58	2
23	1	39	2	59	2
24	...	40	5	60	5
25	2	41	8	61	3
26	2	42	6	62	3
27	...	43	4	63	3
28	1	44	3	64	1
29	2	45	5	65	1
30	7	46	5	66	1
31	3	47	5	67	2
32	3	48	5	68	1
33	3	49	6	69	1
...	...	50	6	70	4
...	...	51	3	71	...
...	...	52	3	72	...
...	...	53	2	75	1
30		76		37=143	

Average age at death :—45·5.

N.B.—15 women are still living. They are therefore not included in this table.

(ii) AGE OF MAN AT DEATH

(31) *Frequency Table.*

Age at death.	Cases.	Age at death.	Cases.	Age at death.	Cases.
26	1	50	8	63	5
28	1	51	2	64	2
29	1	52	3	65	6
34	1	53	4	66	3
40	4	54	5	67	6
41	3	55	4	68	2
42	2	56	3	69	...
43	3	57	3	70	6
44	3	58	2	71	...
45	6	59	4	72	3
46	7	60	10	73	1
47	1	61	2	76	2
48	5	62	5	78	2
49	4	...	...	80	2
...	...	...	...	82	1
...	...	...	...	85	1
42		55		42=139	

Average age at death :—56.2.

N.B.—11 men are still living. They are therefore not included.

B.—FATHER-GENERATION

(i) AGE OF WOMAN AT DEATH

(32) *Frequency Table.*

Age at death.	Cases.	Age at death.	Cases.	Age at death.	Cases.
15	7	32	8	49	10
16	11	33	6	50	10
17	5	34	9	51	3
18	8	35	5	52	6
19	1	36	5	53	1
20	5	37	6	54	2
21	3	38	7	55	2
22	6	39	3	56	2
23	5	40	34	57	1
24	3	41	22	58	1
25	1	42	23	59	1
26	3	43	28	60	...
27	7	44	24	61	...
28	9	45	25	62	...
29	7	46	17	63	...
30	9	47	10	64	2
31	2	48	12	65	2
92		244		43=379	

Average age at death :—38.3.

N. B.—623 women are still living who are therefore not included in this table.

(ii) AGE OF MAN AT DEATH

(38) Frequency Table.

Age at death.	Cases.	Age at death.	Cases.	Age at death.	Cases.
20	3	37	2	54	13
21	4	38	4	55	9
22	6	39	4	56	3
23	4	40	11	57	2
24	3	41	10	58	3
25	5	42	13	59	4
26	6	43	4	60	7
27	4	44	9	61	...
28	6	45	7	62	1
29	6	46	16	63	1
30	8	47	18	64	2
31	4	48	13	65	1
32	3	49	22	66	1
33	1	50	31	67	1
34	3	51	8	68	...
35	1	52	19	73	1
36	5	53	8	75	1
72		199		50=321	

Average age at death :—44·2.

N.B.—647 men are still living who are therefore not included in this table.

From the above tables it is seen that the average age of woman at death in grandfather-generation was 45·5 and that of man in the same generation was 56·2, while the average age of woman at death in father-generation was 38·3 and that of man in the same generation was 44·2.

It will not be fair to draw any conclusions about change in longevity in the two generations studied. For, first of all in spite of many attempts to get information about the brothers and sisters of the men and women of the grandfather-generation I have not succeeded in getting the necessary information. The sample, therefore, of the grandfather-generation is small and perhaps also selected

Secondly, far too many men and women of father-generation are still living.

The following tables will give an idea as to the number and average ages of these men and women.

A.—GRANDFATHER-GENERATION

(i) AGE OF WOMAN STILL LIVING

(34) Frequency Table.

Age of woman still living.	Cases.	Age of woman still living.	Cases.
45	1	61	1
46	...	62	...
47	...	63	2
48	...	64	1
49	...	65	...
50	...	66	2
51	1	67	2
52	...	68	...
53	...	69	...
54	...	70	...
55	...	71	1
56	1	72	...
57	...	73	...
58	1	74	1
59	...	75	...
60	...	77	1

4

11=15

Average age of woman still living :—63.2.

Of these 7 are widows.

(ii) AGE OF MAN STILL LIVING

(35) Frequency Table.

Age of man still living.	Cases.	Age of man still living.	Cases.
55	1	67	1
56	...	68	...
57	...	69	...
58	...	70	1
59	...	71	2
60	...	72	...
61	1	73	...
62	...	74	...
63	1	75	...
64	...	76	1
65	...	77	1
66	...	78	...
...	...	79	1
...	...	80	1

3

8=11

Average age of man still living :—70.

B.—FATHER-GENERATION

(i) AGE OF WOMAN STILL LIVING

(36) Frequency Table.

Age of woman still living	Cases.	Age of woman still living.	Cases.	Age of woman still living.	Cases.
15	1	32	12	50	6
16	3	33	15	51	8
17	7	34	16	52	1
18	13	35	25	53	3
19	7	36	24	54	7
20	9	37	32	55	2
21	16	38	16	56	1
22	7	39	34	57	...
23	11	40	15	58	2
24	10	41	35	59	...
25	12	42	20	60	1
26	18	43	21	61	1
27	32	44	13	62	2
28	19	45	16	63	1
29	19	46	11	64	1
30	11	47	18	72	1
31	47	48	6	74	1
...	...	49	13	86	1
242		342		39=623	

Average age of woman still living :—35.31.

Of these 94 are widows.

(ii) AGE OF MAN STILL LIVING
(37) Frequency Table.

Age of man still living.	Cases.	Age of man still living.	Cases.	Age of man still living.	Cases.
20	1	39	27	57	8
21	4	40	19	58	9
23	14	41	34	59	7
24	2	42	17	60	6
25	15	43	32	61	12
26	10	44	18	62	1
27	6	45	22	63	4
28	8	46	30	64	3
29	14	47	15	65	3
30	7	48	22	66	6
31	18	49	20	67	3
32	10	50	13	68	...
33	9	51	36	69	1
34	16	52	3	70	...
35	30	53	14	71	1
36	16	54	19	73	1
37	12	55	8	77	1
38	26	56	13	86	1

218

362

67=647

Average age of man still living :—43.

From tables 34-37 we see that the average age of woman of grand-father-generation still living is 63.2 and that of man still living in the same generation is 77, while the average age of woman of father-generation still living is 35.3 and that of man still living in the same generation is 43.

It may be surmised from this that the average age at death of men and women of father-generation could not be so low as it indicated in the tables 32 and 33. For a proper comparison between the two generations in respect of longevity we must wait. It is hoped that a further enquiry into the details of the living members of father-generation may be undertaken fifteen years hence. Only then, can a proper comparison be instituted.

B. L. MANKAD

THE UNTOUCHABLE CLASSES OF MAHARASHTRA†

The problem of Untouchability is beset with great difficulties and in order to approach to a right solution, it is highly essential to have first-hand information of the economic and social life of the Untouchable classes. It is also necessary for us to know the grievances and the remedies that these classes themselves have to suggest for them, the scope of their natural aspiration to rise to a higher level in the society and the difficulties that they have to meet therein. I have tried in the following pages to find exactly these things in some of the Marathi speaking Districts of the Bombay Presidency and I feel sure, that from the results that I have got, it is possible to get a fair idea of the position of these classes as regards, both economic and social life, and it also will be easy for us to understand the exact solution for their age-long maladies.

In order to ascertain their social and economic conditions and also their view-point in matters relating to both, I have visited quite a large number of villages in the District that are under my survey, and acquired first-hand information, after moving, talking, and freely associating with them. This, of course, I could not do in all the cases in the families that I have studied and I had to depend in some cases, on the kindness of some local leaders, who furnished me quite promptly, the necessary information. Thus I collected correct information about nearly 600 families from the following Districts.

<i>Districts.</i>						<i>Number of schedules.</i>
1	Kolaba	..	..	..	..	100
2	Thana	.	..	..	..	64
3	Nasik	..	..	..	..	95
4	Satara	..	..	..	..	90
5	Ahmadnagar	..	..	..	..	55
6	Khandesh (East)	..	..	..	..	138
*7	Poona	..	..	..	..	28
*8	Belgaum	..	..	..	..	6
*9	Ratnagiri	..	..	..	..	6
*10	Sholapur	..	..	..	..	7
Total						589

† Summary of the Thesis "Untouchability in Maharashtra," submitted for the degree of M.A. in 1935.

* Schedules from these Districts are not utilised in the following study as they are very few.

The main castes among the Untouchables of the area under survey, are Mahars, Chamars, Mangs, Dhors and Bhangis,* and the following is the analysis of the 542 families that I have studied.

POPULATION

The following tables show the number of families of the different castes of the Untouchables, in the six Districts and the number of members in the families.

TABLE NO. 1.
(Showing the number of families)

Districts	Mahar	Chamar	Mang	Dhor	Bhangi	Total
1 Kolaba ...	67	25	4	...	4	100
2 Thana ...	49	13	...	...	2	64
3 Nasik ...	59	26	2	...	8	95
4 Satara ...	48	8	13	21	...	90
5 Ahmadnagar	37	6	6	6	...	55
6 Khandesh (East)	122	8	6	...	2	138
Total ...	382	86	31	27	16	542

TABLE NO. 2.
(Showing the number of Members in the families.)

Districts	Mahar		Chamar		Mang		Dhor		Bhangi		Total	
	M	F	M	F	M	F	M	F	M	F	M	F
1 Kolaba ...	224	199	100	97	13	11	...	...	11	9	348	316
2 Thana ...	167	142	47	47	...	...	...	...	5	4	219	195
3 Nasik ...	209	241	69	80	4	7	...	...	22	19	304	347
4 Satara ...	140	124	31	31	74	56	65	60	...	...	310	271
5 Ahmadnagar	174	179	21	16	20	21	29	21	...	...	244	237
6 Khandesh (East)	560	594	43	42	30	41	...	...	8	8	641	685
Total ...	1474	1479	311	313	141	136	94	81	46	40	2066	2049

M. = Male ; F. = Female.

* Bhangis are not really Natives of Maharashtra.

From the tables Nos. 1 and 2 we get the following table which shows the average size of a household of each caste in the six Districts. Of these households some may be purely natural families, *i.e.*, parents living only with their unmarried children or with or without children only with the addition of some other relative like unmarried brother or sister, widowed sister, father's sister, brother's child, sister's child, paternal uncle's child, wife's mother, wife's brother or sister, etc. "Such families are essentially natural families, the relatives being such dependants, as do not affect the basic household group of husband and wife."¹ There also may be joint families with more married couples than one, forming a household. But I have made no such differentiation.

TABLE NO. 3.
(Showing the size of families.)

Districts	Mahar	Chamar	Mang	Dhor	Bhangi
1 Kolaba	6.3	7.9	6.0	...	5.0
2 Thana	6.1	7.2	...	...	4.5
3 Nasik	7.6	5.7	5.6	...	5.1
4 Satara	5.5	7.7	10.0	5.9	...
5 Ahmadnagar ...	9.5	6.1	6.8	8.3	...
6 Khandesh (East) ...	9.5	10.7	11.8	...	8.0
Total ...	7.7	7.3	9.0	7.0	5.4

We see that the average size of a family revealed by this inquiry is larger than the average Indian family which is taken to consist of only 5 to 6 persons per family. For instance the average size of a family in Pimpla-Saudagar as also in Jategaon Budruk is found to be 5.² In "Some Village Studies" in the Kolaba District "the average family is found out to be 5.66 persons ;"³ and the survey of the Konkan village also shows that the average size of the family is 4.6.⁴

1. "Some Village Studies," By S. R. Deshpande and Dr. G. S. Ghurye. *Indian Journal of Economics*, Vol. VII, 1926-27, p. 472.

2. "Land & Labour in a Deccan Village," by Dr. H. H. Mann. Study No. 1, p. 124, and Study No. 2, p. 107.

3. "Some Village Studies," By S. R. Deshpande and Dr. G. S. Ghurye. *Indian Journal of Economics*, Vol. VII, 1926-27, p. 472.

4. "Economic and Social Survey of a Konkan Village," By Mr. V. G. Ranade, p. 60.

It can be seen that the Mahars and the Mangs have greater percentage of the family members than the other three castes.

In the case of the Bhangis the percentage of the family members is moderate. The Bhangis are not permanent settlers of these places. They have migrated to this province either from U. P. or from Gujarat. So it might be probable that they must not have here all the members of their families, with them. At times they go in for more than one wife, but they do it only with the intention of adding one more earning member to their families.

TABLE NO. 4.

(Showing the number of females per 100 males.)

Districts			Mahar	Chamar	Mang	Dhor	Bhangi
1	Kolaba ...	...	88	97	84	...	82
2	Thana ...	...	85	100	...	...	80
3	Nasik ...	...	115	116	175	...	86
4	Satara ...	...	88	100	75	92	...
5	Ahmadnagar	...	103	76	105	73	...
6	Khandesh (East)	...	106	98	137	...	100

Thus on the whole, there is an obvious deficiency of females except in Nasik and Khandesh (East) Districts and among the Mahars and the Mangs of Ahmadnagar District. It must be noted that the general proportion as found by the above figures agrees with the average Indian proportion as it can be seen from the Census Reports.

We shall now consider the distribution of population of the different castes in the six Districts according to age.

TABLE NO. 5.

(A) (Mahars.)

Age	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above	Total
Male ...	60	188	214	158	197	268	153	128	68	40	1474
Female	46	195	242	194	242	217	148	103	51	41	1479
Total ...	106	383	456	352	439	485	301	231	119	81	2953

(B) (Chamars.)

Age.	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above.	Total.
Male ...	7	36	52	30	50	51	40	19	11	15	311
Female ...	13	44	42	47	38	43	36	23	15	12	313
Total ...	20	80	94	77	88	94	76	42	26	27	624

(C) (Mangs.)

Age.	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above.	Total.
Male ...	4	11	20	18	19	29	17	10	7	6	141
Female ...	1	15	21	16	23	32	7	12	2	7	136
Total ...	5	26	41	34	42	61	24	22	9	13	277

(D) (Dhors.)

Age.	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above.	Total.
Male ...	5	11	9	8	15	24	11	4	3	4	94
Female ...	3	9	12	7	17	14	10	4	1	4	81
Total ...	8	20	21	15	32	38	21	8	4	8	175

(E) (Bhangis)

Age.	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above.	Total.
Male ...	5	5	9	6	4	7	6	2	1	1	46
Female ...	0	9	4	6	4	9	5	1	2	0	40
Total ...	5	14	13	12	8	16	11	3	3	1	86

It will be seen from the seventh and eighth columns of the Table No. 5A that there is a sharp drop in the number of living persons among the Mahars from 485 to 301.

MARRIAGE

The tables Nos. 6 and 7 show the three categories, *viz.*, Married, Unmarried and Widowed and their percentages to the population of the different castes of the Untouchables.

TABLE NO. 6.

(Male.)

Category	Mahar	%	Chamar	%	Mang	%	Dhor	%	Bhangi	%	Total	%
Unmarried	681	46	128	41	64	45	42	45	24	52	939	45
Married	744	51	176	57	72	51	46	49	22	48	1060	51
Widowed	49	3	7	2	5	4	6	6	0	0	67	4

TABLE NO. 7.

(Female.)

Category	Mahar	%	Chamar	%	Mang	%	Dhor	%	Bhangi	%	Total	%
Unmarried	440	30	84	27	37	27	22	27	15	37	598	29
Married	905	61	200	64	88	65	49	60	25	63	1267	62
Widowed	134	9	29	9	11	8	10	13	0	0	184	9

From tables Nos. 6-9 we can draw the following conclusions :—

(1) There is universality of marriage, among these people as it will be seen from the Tables Nos. 6 and 7, that there are very few males who are unmarried after the age of 20, and there are also very few females who are left unmarried after the age of 15. There is only one case of a Chamar girl in the Kolaba District, who is left unmarried even after the age of 20, as she has been mad from her childhood.

(2) It can be seen from the Tables Nos. 8 and 9 that, of the males aged 16 and above, 84 per cent. are married, 6 per cent. are widowers and the remaining 10 per cent. are unmarried. Of the females aged 16 and above, 83 per cent. are married, 16 per cent. are widows, and hardly 3 per cent. are unmarried. Of the males up to the age of 16, 6 per cent. are married and of the females 36 per cent. are married.

(3) There is a practice of early marriage on a large scale as it can be seen from the Tables Nos. 8 and 9. Out of the males up to the age of 15, 6 per cent. are married and up to the age of 20, 27 per cent. are married. Of the females, after the age of 15, there

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AGE	MAHAR				CHAMAR				MANG				DHOR				BHANGI				TOTAL			
	M		W		M		U		M		U		W		M		U		M		W		Total	
	M	U	W	Total	M	U	W	Total	M	U	W	Total	M	U	W	Total	M	U	W	Total	M	U	W	Total
1-15 ...	31	588	1	620	10	115	...	125	2	51	...	53	1	32	...	33	4	21	...	25	48	807	1	856
16 & above	713	93	48	854	166	13	7	186	70	13	5	88	45	10	6	61	18	3	...	21	1012	132	66	1210
Total ...	744	681	49	1474	176	128	7	311	72	64	5	141	46	42	6	94	22	24	...	46	1060	939	67	2066

No. 9.
(Female.)

AGE	MAHAR			CHAMAR			MANG			DHOR			BHANGI			TOTAL								
	M	U	W	Total	M	U	W	Total	M	U	W	Total	M	U	W	Total	M	U	W	Total				
1-15 ...	238	439	...	677	63	83	...	146	17	36	...	53	9	22	...	31	4	15	...	19	331	595	...	926
16 & above	667	1	134	802	137	1	29	167	71	1	11	83	40	...	10	50	21	...	...	21	936	3	184	1123
Total ...	905	440	134	1479	200	84	29	313	88	37	11	136	49	22	10	81	25	15	...	40	1267	598	184	2049

NOTE :—M = Married ; U = Unmarried ; W = Widowed.

are only 3 girls who are left unmarried out of 2,049 females and one of them as stated above, is a mad girl. Thus we may conclude that early marriage among them is almost the rule.

(4) There is a large proportion of widows as it can be seen from the Table No. 9. Up to the age of 15 there are no widows but after that age, there are 184 widows out of 1,123 females, which means the percentage of the widows to the total number of females above 15 is 16. At the same time it is seen from the Table No. 8 that out of 1,210 males there are 66 males that is 6 per cent. who are widowers.

DEATH

TABLE NO. 10.

(Male.)

(Showing Deaths according to ages.)

Caste.	Below 1	1-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61 & above.	Total
Mahar ...	73	70	9	12	7	15	3	11	24	14	238
Chamar ...	30	15	1	3	2	4	3	4	5	11	78
Mang ...	2	5	1	0	0	1	0	0	0	6	15
Dhor ...	10	7	0	1	0	1	0	3	3	3	28
Bhangi ...	4	7	0	1	0	0	0	0	0	0	12
Total ...	119	104	11	17	9	21	6	18	32	34	371

TABLE NO. 11.

(Female.)

(Showing Deaths according to ages.)

Caste.	Below 1	1-5	6-10	11-15	16-20	21-30	40-51	41-50	51-60	61 & above.	Total
Mahar ...	44	49	17	10	13	18	9	22	13	8	203
Chamar ...	9	10	7	3	5	6	4	6	2	3	55
Mang ...	4	8	3	0	1	4	1	0	2	3	26
Dhor ...	3	3	3	0	0	3	1	1	0	1	15
Bhangi ...	1	1	0	0	1	0	0	0	0	0	3
Total ...	61	71	30	13	20	31	15	29	17	15	302

According to the data that I have at my disposal, the number of deaths that might have occurred, during the last ten years, are tabulated above. Yet it cannot be said with certainty that all deaths that might have occurred during the last ten years, have been recorded here. The above tables are the simple records of the number of deaths that have occurred, at the different ages, during the last ten years, and from these tables we can roughly draw the following conclusions :

(1) The total number of deaths among these classes is 673 while the total number of deaths below the age of one year is 180. Thus the percentage of infant deaths per 100 of total deaths is 26·7. The highest percentage of infant deaths in the Bombay Presidency, during the last five years, recorded is 24·48. From these figures we can conclude that the infant mortality among these classes is very high.*

(2) The percentage of deaths below six years, among the males is 60, and among the females is 44, which means on an average child mortality is very high among these people within the first five years of life.

(3) The number of deaths between the ages of 16 to 20 and 21 to 30 is proportionately higher among the females than among the males. This may probably be due to the risks attendant on pregnancy.

(4) After the age of 50 the number of deaths among males are proportionately higher than the number of deaths among women.

LITERACY

TABLE NO. 12.

(Showing literacy among different castes of the Untouchables.)

Caste.	Males.			Females.			Total.		
	No. of Liter.	No. of Illit.	Total.	No. of Liter.	No. of Illit.	Total.	No. of Liter.	No. of Illit.	Total.
Mahar ...	314	1160	1474	37	1442	1479	351	2602	2953
Chamar ...	94	217	311	5	308	313	99	525	624
Mang ...	33	108	141	0	136	136	33	244	277
Dhor ...	21	73	94	2	79	81	23	152	175
Bhangi ...	7	39	46	0	40	40	7	79	86
Total ...	469	1597	2066	44	2005	2049	513	3602	4115

* Seventieth Annual Report of the Director of Public Health for the Government of Bombay, 1933, p. 10.

TABLE NO. 13.

(Showing literacy of the Untouchables in the six Districts.)

Districts.	Males.			Females.			Total.		
	No. of Liter.	No. of Illit.	Total.	No. of Liter.	No. of Illit.	Total.	No. of Liter.	No. of Illit.	Total
1. Kolaba ...	126	222	348	9	307	316	135	529	664
2. Thana ...	41	178	219	4	189	193	45	367	412
3. Nasik ...	87	217	304	15	332	347	102	549	651
4. Satara ...	92	218	310	8	263	271	100	481	581
5. Ahmad-nagar.	63	181	244	4	233	237	67	414	481
6. Khandesh (East)	60	581	641	4	681	685	64	1262	1326
Total ...	469	1597	2066	44	2005	2049	513	3602	4115

TABLE NO. 14.

(Showing standard of literacy.)

Districts	Mahar			Chamar			Mang			Dhor			Bhangi			Total		
	V. F. & Trained	Matric	Higher Edu.	V. F. & Trained	Matric	Higher Edu.	V. F. & Trained	Matric	Higher Edu.	V. F. & Trained	Matric	Higher Edu.	V. F. & Trained	Matric	Higher Edu.	V. F. & Trained	Matric	Higher Edu.
Kolaba ...	4	1	...	2	...	...	...	...	...	...	...	...	...	...	...	6	1	...
Thana ...	5	...	...	1	...	...	...	...	...	...	...	...	...	...	...	6	...	...
Nasik ...	5	1	...	...	...	...	...	...	...	...	...	...	...	...	...	5	1	...
Satara ...	7	1	1	...	...	...	1	...	...	...	2	...	...	...	...	8	1	3
Ahmadnagar...	3	...	...	...	1	...	...	...	...	...	1	...	...	...	...	3	1	1
Khandesh (East)	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...
Total ...	25	3	1	3	1	...	1	...	...	...	3	...	...	...	...	29	4	4

TABLE NO. 15.

(Showing English Literacy.)

Districts	Mahar	Chamar	Mang	Dhór	Bhangí	Total
1 Kolaba ...	21	2	...	...	...	23
2 Thana ...	1	...	...	...	...	1
3 Nasik ...	13	1	...	...	...	14
4 Satara ...	8	7	3	7	...	25
5 Ahmadnagar ...	8	2	1	2	...	13
6 Khandesh (East) ...	...	...	...	...	...	...
* Total ...	51	12	4	9	...	76

From the above tables we get the following conclusions :—

(1) The percentage of literacy among the Chamars is higher than any of the other castes of the Untouchables. This might be due to the fact that the Chamars are economically better off than any of the other castes of the Untouchables.

(2) Although the percentage of literacy among Mahars is less than the Chamars, yet the number of persons who have passed the Vernacular final examination, who have taken Secondary and Higher education, is proportionately greater than any of the other castes of the Untouchables, as it can be seen from the Table No. 14.

(3) The Mangs have less percentage of literacy than the other castes of Untouchables except Bhangis. They have the poorest lot, as they are economically very backward.

(4) Out of the total number of women 2,049, there are only 44 women who are literate, *i.e.*, who are just able to read and write. The rest of them, *i.e.*, nearly 98 per cent. are totally illiterate.

(5) The percentage of literacy in English is higher in Satara District than in any of the other Districts.

(6) The percentage in English literacy in the Kolaba District is recorded here, higher, on account of the Military Pensioners residing in the District.

(7) Nasik has a fair percentage of literacy in English probably due to the following reasons :—

- (a) There is general awakening of these people on a larger scale than any other District.
- (b) There is provision for English education for the Railway Servant at Manmad and there is a fair representation of the Untouchables (especially of the Mahars) in the Railway Service. Naturally these people find convenient to send their children to the High School.
- (c) The average economic conditions of these people, in this District are far better than that of any other District under survey, and that may be the reason why there is a high percentage of literacy.
- (d) There are hostels meant for these people at two places and the Railway line running through the District as well as a quick Motor Service between the Taluka Towns help the parents to keep their children, in the hostels, at distant places.

(8) Ahmadnagar has a fair percentage of literacy in English. It may probably be due to the Missionary activities of helping these people in matters of education and others, as Ahmadnagar is the stronghold of Missionary activities in Maharashtra.

(9) Khandesh (East) is the most backward District as far as literacy is concerned due to its economic backwardness.

(10) The table No. 14 shows that the Mahars have larger percentage of English knowing persons. This shows that the Mahars have become more keen, in having higher education than any other community of the Untouchables.

(11) There is only one girl in the Kolaba District, who can be said to be literate in English by courtesy as she has taken education in English up to the Third Standard.

On the whole it must be noted that the percentage of literacy is much higher than what is actually recorded in the Census Report of 1931. Most of the villages from which I have collected the statistics have primary schools in the villages or in the near vicinity. On the other hand there are a large number of villages in Maharashtra without any school, even within an area of three miles from the village proper,

OCCUPATION

TABLE NO. 16.

(Showing the number of persons following different occupations.)

	Mahar.			Chamar.			Mang.			Dhor.			Bhangi.			Total.		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
1 Agri- culture.	177	128	305	20	21	41	1	2	3	2	4	6	...	...	...	200	155	355
2 Pub. Admn.	15	...	15	2	...	2	...	...	...	...	...	...	...	...	...	17	...	17
3 Vatan	75	...	75	...	...	...	...	...	...	...	...	...	...	...	...	75	...	75
4 Casual Labour.	356	311	667	9	33	42	7	9	16	7	9	16	...	...	...	379	362	741
5 Swee- pers.	9	2	11	...	...	...	...	...	...	...	...	...	...	...	...	9	2	11
6 Tea- chers.	26	...	26	3	...	3	1	...	1	...	...	...	...	...	...	30	...	30
7 Sca- vengers.	...	...	...	...	...	...	...	...	...	...	...	...	20	13	33	20	13	33
8 Shop- keepers.	2	...	2	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2
9 Car- penters.	8	...	8	...	...	...	1	...	1	...	...	...	...	...	...	9	...	9
10 Priests	2	...	2	1	...	1	...	...	...	...	...	...	...	...	...	3	...	3
11 Rope- makers.	...	...	...	...	...	...	52	38	90	...	...	...	...	...	...	52	38	90
12 Shoe- makers.	...	...	...	110	...	110	...	...	...	...	...	...	...	...	...	110	...	110
13 Busi- ness.	8	...	8	...	...	...	3	...	3	3	...	3	...	...	...	14	...	14
14 Domes- tic Service.	18	...	18	4	...	4	...	...	...	...	...	...	...	...	...	22	...	22
15 Tan- ning.	...	...	...	...	...	...	...	...	...	34	7	41	...	...	...	34	7	41
16 Carts- men.	5	...	5	...	...	...	...	...	...	...	...	...	...	...	...	5	...	5
17 Miscel.	9	1	10	...	...	...	...	...	...	...	...	...	...	...	...	9	1	10
Total ...	710	442	1152	149	54	203	65	49	114	46	20	66	20	13	33	990	578	1568

N.B.—M = Male ; F = Female ; T = Total.

If we take into consideration the four broad divisions of occupations, *viz.*, Agriculture, Casual Labour, Hereditary occupations and the rest, we get the following table.

TABLE NO. 17.
(In percentage.)

Nature of Occupation	Mahar	Chamar	Mang	Dhor	Bhangi	Total
Agriculture ...	26.5	20.0	2.6	9.0	...	22.6
Casual Labour ...	58.0	21.0	14.0	26.0	...	47.4
Hereditary Occupation ...	6.5	54.0	79.0	62.0	100.0	23.0
Other Occupations ...	9.0	5.0	4.4	3.0	...	7.0

From the above tables we come to the following conclusions :-

(1) A majority of these people except the Mahars, are depending upon their hereditary occupations. The Mahars have no permanent occupation yielding permanent income. Some of them have the Vatsans but the payment they get for their services is so low that they have to depend upon other sources of income or upon the earnings of the other members of their families. This can be seen from the questions put and the answers received from the Government, in the Bombay Legislative Council debates that a Mahar in the Thana and Ahmadnagar Districts gets Rs. 1|8 per month from the Government for his services; in the East Khandesh District he gets Rs. 1|12; in the Nasik District he gets 13 as. 4 p. per month and in the Satara District he gets 2 as. 1 p. per month.¹ The other sources of income of these Mahars who are holding the Vatsans, are the Inam lands and the Baluta or the collection of grain from the villagers. The lands given Inam to these people are divided and sub-divided now, to such an extent that they get practically no income or so little, that it is insignificant. As far as the Baluta is concerned nothing can be said with certainty about its collection. It all depends upon the economic conditions and goodwill of the villagers. In my investigations I have found, that in quite a large number of villages, for some reason or the other, the relations of the Mahars are not in perfect harmony with the villagers and naturally they have to forego the income they would have received from the Baluta. Besides the villagers themselves are reduced to such poverty that they are never in a position to part with any portion of their income which is itself insufficient for their needs.

The Mahars carry on also the skinning work of dead animals but it yields very little income and therefore it cannot be taken as a substantial addition to their total income.

1. "Bombay Legislative Council Debates" Official Report, Vol. XXIII, page 710.

(2) As the Mahars have no regular hereditary occupation, naturally they have to depend upon other types of occupations and that is the reason why we find 58 per cent. of them wholly depending upon Casual Labour. But Casual Labour is not found at all times of the year and on all occasions. It is casual in type of occupation and also it is casual in duration of time. Moreover, demand for such labour also depends upon the general economic condition of the population. So it cannot be said with certainty that these people who are depending upon Casual Labour, can get it, at all times. On the contrary, leaving aside a few days during the harvest time, a majority of these people find it very difficult to get employment even for ten days on an average, out of a month, and for the rest of the time they have nothing to do but to sit idle. That is the reason why we find economic backwardness among them to a greater extent, than among the Chamars and the Bhangis who have some hereditary occupation of their own.

(3) As far as agriculture is concerned 26.5 per cent. of the Mahars and 20 per cent. of the Chamars are depending upon it. But only very few of them have lands of their own, and the majority of them are cultivating the rented lands, with the result that they find it very difficult to depend upon agriculture solely, for their maintenance.

(4) The Mangs are not so much depending upon agriculture, probably because they have a hereditary occupation of their own. They are economically so low that they have no capital to invest nor have they sufficient credit to raise any loan for initial expenses. Besides, more or less they are taken to be wandering tribes and naturally they have no status in any particular village.

(5) Although the number of persons, following other occupations such as Teaching, Carpentry, Shop-keeping, Business, Public Administration, etc., is to some little extent higher among Mahars than the other castes, still on the whole they are very few, not even one per cent. of the total number of persons following the different occupations. The reasons for this are obvious. Firstly, they are educationally very backward; so naturally they are very few in number, in the teaching profession and in public administration. Secondly, as far as shop-keeping and carpentry are concerned their untouchability comes in their way and it is not possible for them to carry on these occupations on a large scale, as there will be no public demand. The few persons, only ten in number, who are following these occupations, depend upon their own people, and in few cases upon the Mohammedans.

(6) As far as business is concerned, it has become possible

for a few Mahars only in Nasik District and for a few Mangs and Dhors in the Satara District to do this. In the Nasik District the Railway line passing through the District, has helped them to take petty contracts of supplying sand, stones, bricks, etc., and also of constructing small buildings for the Railway purposes. Thus it has helped a few of them to improve to some extent, their economic conditions and thus some of them are able to take big contracts for constructing buildings, etc., for others than the Railway Company. In Satara and Ahmadnagar Districts the Dhors carry the business of getting raw skins from the Mahars and after tanning them they supply them to the leather-merchants in the cities. This has helped them to improve their economic condition.

(7) I have found that in some parts of the Thana District, where the Railway line is running through, it has become possible for a few Mahars to carry on the occupation of cartmen.

(8) A very few of them, especially the Mahars, carry on the occupation of priesthood. They conduct the marriages of their own community and guide them in other religious affairs.

(9) Eighteen persons among the Mahars and four persons among the Chamars are employed as domestic servants. Of the Mahars, most of them are employed with Mohammedans who have advanced debt to them for their marriage purposes and in return they have to serve a fixed number of years as domestic servants. During their service they get very insignificant remuneration from their employers.

(10) A few of the Mahars are economically so backward that they cannot follow any occupation and are forced to resort to begging.

TABLE NO. 18.

(Showing Earners, Subsidiary Earners and Dependants.)

CASTE	Principal Earners			Subsidiary Earners			Dependants			Total		
	M	F	T	M	F	T	M	F	T	M	F	T
Mahar ...	374	6	380	337	435	772	763	1038	1801	1474	1479	2953
Chamar ...	86	...	86	63	54	117	162	259	421	311	313	624
Mang ...	31	...	31	34	49	83	76	87	163	141	136	277
Dhor ...	27	...	27	19	20	39	48	61	109	94	81	175
Bhangi ...	16	...	16	4	13	17	26	27	53	46	40	86
Total ...	534	6	540	457	571	1028	1075	1472	2547	2066	2049	4115

NOTE.—M = Male ; F = Female ; T = Total.

TABLE NO. 19.

(In percentage.)

CASTE	EARNERS		DEPENDANTS	
	Male	Female	Male	Female
Mahar	48	29	52	71
Chamar	48	17	52	83
Mang	46	36	54	64
Dhor	49	25	51	75
Bhangi	44	33	56	67

• From these tables we arrive at the following broad conclusions :—

(1) The percentage of male earners is, roughly speaking, uniform being 48 per cent. in all the castes except in the Bhangis.

(2) Among the female earners the Mangs have greater percentage than any other castes of the Untouchables. Rope-twining is a convenient occupation which can be managed by women, during their leisure hours.

(3) Thirty-three per cent. of the Bhangi women are employed and they all carry on no other work except scavenging.

(4) Some of the Mahar women carry on, the Agricultural work or get some casual labour as well as agricultural labour.

If we leave aside the number of children below the age of 15 and old men and women above the age of 50, we get the following percentages of earners among the males and females of the Untouchable classes.

TABLE NO. 20.

(In percentage.)

Percentage.	Mahar.	Chamar.	Mang.	Dhor.	Bhangi.
Male	84	93	88	85	100
Female	62	39	66	45	67

From the above table it is seen, that among males, the Bhangis and the Chamars have more employment than the other castes. These people have their hereditary occupation which allows better scope for work than the other hereditary occupations.

EARNINGS

TABLE NO. 21.

(Showing the number of households having different monthly income.)

Caste	Monthly Income in Rs.									Total.
	1-5	6-10	11-15	16-20	21-25	26-30	31-40	41-50	51 & above.	
Mahar ...	105	137	56	32	15	11	16	3	4	379*
Chamar ...	8	16	19	14	11	2	7	4	3	84*
Mang ...	9	11	6	3	...	...	1	1	...	31
Dhor ...	6	9	3	1	4	...	...	2	2	27
Bhangi ...	...	...	2	2	1	7	2	1	1	16
Total ...	128	173	86	52	31	20	26	11	10	537*

From the above table we get the following conclusions :—

(1) On the whole, taking a general view of the Untouchables, we find that 24 per cent. of their families have monthly income of less than Rs. 5 and nearly 32 per cent. of them have a monthly income of more than Rs. 5 but less than Rs. 10. This shows that the majority of them is in utterly depressed conditions, as far as their economic conditions are concerned.

(2) The Mahars and the Mangs are extremely poor as it can be seen that nearly 64 per cent. of the Mahars and 65 per cent. of the Mangs have monthly income of not more than Rs. 10.

(3) The Chamars and the Bhangis are economically a bit better off than the Mahars and the Mangs, probably because they have their own hereditary occupations.

* In Kolaba District 3 families from the Mahar community and 2 families from the Chamar community are omitted on account of want of information.

TABLE No. 22.

(Showing average income in Rupees per family and per capita.)

Caste.	No. of Families.	Total income per month.	Income per month.	Income per month per capita.
Mahar	379*	4358/12	11.5	1.5
Chamar	84*	1635/4	19.5	2.6
Mang	31	342/8	11.1	1.2
Dhor	27	1459	21.5**	2.9**
Bhangi	16	451	28.2	5.2
Total	537*	8246/8	13.5	2.0

The above table gives us the following indications :—

(1) The average annual income of a Mahar family comes to Rs. 138, that of a Chamar family comes to Rs. 234, that of a Mang family comes to nearly Rs. 133, and that of a Bhangi family comes to Rs. 338/8. In the case of a Dhor family some explanation is necessary. There are 27 Dhor families and the total monthly income as given in the above table is Rs. 1,459. But there is one family having the exceptional income of Rs. 1,000 per month. So leaving aside that family the average annual income of a Dhor family comes to nearly Rs. 212.

If we compare these figures with the incomes of agriculturists made known through the few studies in this area, we find how some of the Untouchable castes on the whole, are extremely economically backward. For instance the annual income per family of Pimpla Soudagar is Rs. 218¹; and that of Jategaon Budruk a village in the Poona District is Rs. 169/13². In some villages of the Kolaba District, the annual income per family is Rs. 218/6/11³, lastly in the "social and

* In Kolaba District 3 families from the Mahar community and 2 families from the Chamar community are omitted on account of want of information.

** Leaving aside the exceptional family of having the income of Rs. 1,000 per month.

1. "Land and Labour in a Deccan Village," Study No. 1, by Dr. Mann, page 129.

2. "Land and Labour in Deccan Village," Study No. 2, By Dr. Mann, page 116.

3. "Indian Journal of Economics," Vol. VII, 1926-27, page 427. "Some Village Studies," By Mr. Deshpande and Dr. Ghurye.

economic survey of a Konkan village" the annual income per family is found to be Rs. 281.¹

Judging from the above figures we can say that the Mahars and the Mangs are far below the average standard of income of an average villager that is found out from the above studies. The Dhors and the Chamars are just on the line of the average standard of income and it is only the Bhangis that have an income one and half times that of an average villager.

(2) Leaving aside the Bhangis the annual income per capita of the other castes is extremely low and it is not sufficient to satisfy the necessary requirements.

CATTLE

What Dr. Mann says regarding the position of the agricultural stock of the Deccan is practically true in the case of all the six Districts under survey. He says, "It can never be insisted on too much, that most of the Deccan is not really a cattle country. The grazing almost everywhere is poor and though it is a country in which sheep and goats can find a living, cattle have either to be fed for a considerable part of the year or they are half starved, and at intervals of few years there comes a famine and a large number die and disappear."² "In a few places where waste land abound, or where the facilities of fodder and water are particularly good, large number of cattle are kept, and sheep and goat are pastured during the part of the year. But with all this, the animals are relatively few and are chiefly kept for actual use."³

This is the case regarding the general agricultural classes but out of the untouchables that are under my survey 22.6 per cent. depend upon agriculture and the rest either on agricultural labour or on their hereditary occupations. Naturally they are never in a pressing necessity nor can they afford to keep cattle. For instance the Bhangis are in no way concerned with agriculture and have none of the agricultural stock. Besides a large number of the Untouchables do not own the land they cultivate. It has been rented to them and naturally it will not be economically a good bargain to keep the cattle throughout, when practically for all the seasons of the year except

1. "Social and Economic Survey of a Konkan Village," By Mr. V. G. Ranade, page 93.

2. "Land and Labour in a Deccan Village," By Dr. Mann, Study No. 1, page 97.

3. "Land and Labour in a Deccan Village," By Dr. Mann, Study No. 1, page 116.

one, they have no work. In such cases they hire the neighbour's bullocks at the time of sowing and anyhow finish their work of ploughing.

The actual number of the animals belonging to these classes may be seen from the following table.

TABLE NO. 23.
(Showing number of cattle.)

CASTE	Milking Animals		Working Animals		Ovine Cattle		Total Cattle	
	Cows	She-Buf.	Bull.	He-Buf.	Sheep	Other Animals	Bovine	Ovine
Mahar ...	207	32	290	30	126	6	559	132
Chamar	76	14	64	20	19	2	174	21
*Mang ...	13	5	16	...	44	3	34	47
Dhor ...	14	10	29	...	5	3	53	8
Bhangi ...	...	...	...	...	...	...	...	...
Total ...	310	61	399	50	184	14	820	208

The Bovine cattle are not evenly distributed among these people but are found mostly with those people who are depending on agriculture for their maintenance. They are 26.5 per cent. among the Mahars, 20.0 among the Chamars, 2.6 per cent. among the Mangs and 9.0 per cent. among the Dhors.

Milking Animals :—The milking animals are comparatively fewer with these people than the other agricultural Hindu classes as it will be seen from the study of the two villages in the Deccan by Dr. Mann, and the study of one village in the Konkan by Mr. V. G. Ranade. Here their position is peculiar and their untouchability is responsible for it. No caste Hindu would think of buying milk from these people owing to caste prejudices. Nay, even the caste differentiation goes to such an extent, that the Mahar is unwilling to take milk from the Mang and the Chamar never takes it from the Bhangi. So "There are minute rules as to what sort of food or drink can be accepted by a person and from what caste."¹ In short the whole caste system is based upon the restrictions on feeding and drinking. Consequently none can take even water from these people, much less milk and food. The result is obvious. There is no demand for the milk that they get from the cows and she-buffaloes and it is thus

1. "Castes and Race in India," By G. S. Ghurye, p. 7.

wasted. For, rarely they are in the habit of preparing curds and butter-milk, etc., out of it. So generally what they do is that they take out the necessary milk that is required for tea and for the children and the rest they allow the calves to suck. It is true that "the production of milk for urban consumers presents problems of great complexity."¹ So what is true of the agriculturists is also true of the Untouchables. The only difference is that the other agriculturists use milk for its other products which somehow or other is not in vogue among the Untouchables. "All of them are principally concerned with the cow as the mother of their bullocks and attach only secondary importance to its milking capacity."²

All the cattle that they possess are not necessarily bought by them. There is a practice prevalent in almost all these Districts that a small female calf is given to anybody to be brought up and after it is fully grown into a cow is to be returned to the owner after taking its first issue. Thus it becomes convenient for them to have bullocks for the agricultural purposes which is their main point in view, in passing through all these transactions.

Lastly as far as the ovine cattle are concerned they are not kept on a large scale and as such they cannot be said to be of any substantial economic help to them. They are kept more for the sake of hobby than for utility.

MARRIAGE EXPENDITURE

Although there might be various causes of indebtedness of the Untouchables, such as recurrence of bad seasons in some Districts as Ahmadnagar and East Khandesh, the small margin of profit even in good years, want of suitable work, especially for Mahars and Mangs and women of all these classes, during all the seasons of the year, the joint family system among them which "tends to create drones and helps to swell the number of dependants whom the working members of the family have to support," universal poverty among them, and the usurious and oppressive methods pursued by the Sowcars, yet the principal cause that I have found which leads them to perpetual indebtedness is proportionately the heavy expenditure that they incur on marriage purposes which they try to perform with their utmost pomp in order to keep up their prestige and which more or less has become the unwritten law of these communities. For instance, the following is the actual expenditure of a Mahar boy's marriage in the Panvel Taluka, Kolaba District, whose family income is not more than Rs. 7½ a month, and who has to support a family of six members.

1. Royal Commission Report on Agriculture in India, p. 23.

2. *Ibid.*, p. 23.

An account of marriage expenditure of a Mahar boy in the Panvel Taluka, Kolaba District, in 1930.

Rs. a. p.

25—0—0	For ornaments for the bride (Rs. 10 for a necklace and Rs. 15 for a Vela).
1—8—0	Ornaments for the toes and fingers of the bride.
2—0—0	"Mangal-Sutra" a sort of necklace to be worn by the bride on the marriage day.
4—0—0	Special Saree for the bride's mother.
4—0—0	Green Saree for the bride.
3—0—0	White Saree for the bride.
8—0—0	Special Saree for the bride.
2—0—0	Special Bodice made of rich cloth for the bride.
10—0—0	Saree and Dhoties for the bride's sisters and brothers.
2—0—0	Spent on liquor on the first day when the offer of marriage was made.
2—0—0	Spent on liquor for those who had gone to the market to purchase Sarees, Dhoties and other cloth.
5—0—0	Spent while returning back with the bride to the bridegroom's house for liquor.
11—4—0	Given to the Community for the marriage celebrations.
25—0—0	Cost of 3 goats given to the community for the marriage
15—0—0	Cost of dinner given to those who had assembled on the marriage day.
20—0—0	Total expenses during the four marriage days for dinner etc.
10—0—0	Expense of the dinner given to relatives.
1—4—0	Given to a Brahmin when he was consulted.
3—0—0	Fees of the Mahar Joshi who conducted the marriage ceremony.
25—0—0	Dowry given to the bride's father on the day of betrothal.
7—0—0	Wages of the Music instrumentalists engaged during the marriage days.
0—8—0	Expenses for dismantling the marriage Mandap.

186—8—0 Total.

From the above statement we can see how these people spend on marriage purposes lavishly, without the least consideration of their economic position. The result is obvious. They have to incur debt even at usurious rates of interest and there is no wonder that a major portion of them "are born in debt, live in debt and die in debt." As for instance the above family of which the account of marriage expenses is given is under a debt of Rs. 250 out of which Rs. 150 are borrowed on the condition that 18 maunds of paddy are to be given per year to the creditor as interest on the sum. This means that according to the prevailing prices of paddy the rate of interest per annum will be 18 per cent. But this is according to the present day prices of the paddy, but at the time when the debt was incurred the price of the paddy was double that of the present day and the rate of

interest that was fixed was 36 per cent. The remaining Rs. 100 were borrowed at the time of the marriage, that is 4 years back, on the condition that he was to give annually for 4 years 20 maunds of paddy. Taking into consideration the prices of paddy that were, at that time Rs. 2¼ to Rs. 2⅞ per maund, he had to pay back Rs. 180 within four years for the sum he had borrowed. He has failed to return back the sum or to pay it in kind and the creditor has filed a suit against him. Now it is left to us to imagine what will be the fate of the debtor.

This system of spending excessively for the marriage purposes is not prevalent among the Mahars only, but is universally common in all the castes of the Untouchables as it will be seen from the following table :—

TABLE NO. 24.

(Showing the marriage expenses of the different castes of the Untouchables.)

Amount of Expenditure In Rupees	MAHAR		CHAMAR		MANG		DHOR		BHANGI	
	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.
Below 50	27	1110	1	50	5	175	1	25	...	...
51-100	56	5017	5	475	9	835	2	200	...	...
101-150	54	7425	5	695	1	130	...	...	2	275
151-200	45	8817	11	2200	2	400	5	1000	1	200
201-250	22	5450	8	2000	1	225	...	...	...	...
251-300	18	5350	10	3000	4	1175	...	...	...	...
301-350	4	1375	9	3150	...	...	2	700	1	350
351-400	4	1600	9	3600	1	400	2	800	...	...
401-450	...	...	4	1800	...	...	5	2250	2	900
451-500	2	1000	4	2000	...	...	2	1000	...	...
501-600	1	600	2	1150	...	...	1	600	...	...
601-700	...	...	1	700	...	...	...	...	...	...
701-800	...	...	...	...	...	...	...	...	2	1550
801-1000	...	...	...	...	...	...	...	...	2	1750
1001 and above.	...	...	...	...	...	...	1	6000	...	...
Total ...	233	37744	69	20820	23	3340	21	12575	10	5025

It can be seen that of these classes, the Bhangis have to spend much more than any other castes. The dowry that they have to pay to the bride's father varies from Rs. 100 to Rs. 500 ; and other items of expenditure that they have to suffer which is uncommon to other castes is the travelling expenses. The Bhangis are scattered far and wide in the important cities of Maharashtra, where the scavenging system is introduced. It will not be always possible to find the local bride and so they have to hunt from places to places or in Bombay which is supposed to be a central place of these people ; and in case of settlement of marriage the bridegroom's family is to go to the bride's place. This naturally involves heavy expenditure of travelling which at times goes to Rs. 100 to Rs. 200. I have found out a case in the Nasik District where out of the total marriage expenditure of Rs. 900 nearly Rs. 650 were spent on dowry and the travelling expenses and the rest on the other items of marriage. He had incurred a debt of Rs. 900 for the expenses and there will be no reason for us to believe that he will not remain perpetually in debt.

From the above table we can see that of all the castes of the Untouchables the Mangs spend the least on the marriage ceremonies as they are financially very backward. Yet they are not immune from the marriage debts and from the unhealthy consequences thereof. To them, also, a Sowcar for marriage debt is an " indispensable necessity " and as they have the least security to offer, they are totally crushed under the heavy and usurious rates of interest of the Pathan Sowcars. We will now see in comparison with the above table the marriage debts that these classes incur. But before that it must be remembered that such extravagant expenditure for marriage purpose is not confined only to the Untouchable classes. The other classes of Hindus, especially the agriculturists and the labourers are also in the habit of spending very much above their capacity and unfortunately they have also to suffer the same sad consequences of their indebtedness.

It is seen from the table No. 25 that out of 233 Mahar families 199 families, that is 85 per cent. had to incur debt for the marriage expenses ; of the 69 Chamar families, 55 families that is 80 per cent. are indebted for marriage purposes ; so also 78 per cent. of the Mang families, 62 per cent. of the Dhor families and 90 per cent. of the Bhangi families had to approach the Sowcars for debt, with which they have celebrated their sons' and daughters' marriages. Most of the Mahars have no sound economic standing. For the little land they had, has slowly passed into the Sowcars' hands. They have now been reduced to the position of hired labourers. To them the problem of indebtedness is a very difficult nut to crack. They have

TABLE NO. 25.

(Marriage Debt.)

Amount in Rupees	MAHAR		CHAMAR		MANG		DHOR		BHANGI	
	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.	No. of Families	Total Amt.
50 & Below	25	1040	1	50	5	155	...	...	...	...
51-100	55	4960	6	575	6	535	3	300	...	...
101-150	45	6150	7	970	1	130	1	150	2	275
151-200	39	7667	19	3775	...	...	4	800	1	200
201-250	17	4225	8	2000	1	225	...	...	...	...
251-300	13	3850	6	1800	4	1175	2	600	...	...
301-350	3	1050	3	1050	...	...	...	...	1	350
351-400	...	...	1	400	1	400	1	400	...	...
401-450	...	...	1	450	...	...	2	900	2	900
451-500	2	1000	2	1000	...	...	...	...	...	...
501-600	...	...	...	...	...	...	...	...	...	...
601-700	...	...	1	700	...	...	...	...	...	...
701-800	...	...	...	...	...	...	...	...	1	800
801-1000	...	...	...	...	...	...	...	...	2	1750
1000 and above	...	...	...	...	...	...	...	...	...	...
TOTAL	199	29942	55	12770	18	2620	13	3150	9	4275

no other course open but to work as agricultural labourers on the Sowcar's farms or as domestic servants in the Muslim Sowcar houses. The debt that they borrow for the marriage purposes is recovered by means of service for a certain number of years as domestic servants. For instance one Mahar boy of the village Badlapur, District Thana, who got married last year at the age of 15, is under a debt of Rs. 100 taken from a local Muslim Sowcar. He has to serve for a period of seven years as a domestic servant in that Muslim Sowcar's house and after that period he will be set free. During the service he is to get food and fixed number of clothes and a pair of sandals. This practice is to some extent, in vogue, practically in all the Districts in which I have carried my research work but more particularly it is very much in common usage in the Kolaba and Thana Districts.

TABLE NO. 26.

(Showing marriage expenses, marriage debt and debt for other than marriage purposes.)

Caste.	Families incurring debt for marriage purposes.				Families incurring debt for other than marriage purposes.							
					Families incurring no debt for marriage expenses.				Families having no marriages and yet in debt.			
	No. of Families.	Marriage expenses.	Marriage Debt.	Present Debt.	No. of Families.	Marriage expenses.	Marriage Debt.	Present Debt.	No. of Families.	Marriage expenses.	Marriage Debt.	Present Debt.
Mahar...	199	32,557	29,942	21,744/8	34	5,187	...	4,780	79	...	...	8,497
Chamar	55	17,095	12,770	7,540	14	3,725	...	450	13	...	...	988
Mang ...	18	2,655	2,620	1,745	5	685	...	...	3	...	...	150
Dhof ...	13	3,750	3,150	2,275	8	8,825	...	400	1	...	...	100
Bhangi	9	4,275	4,275	2,776	1	750	...	...	4	...	...	570
Total ...	294	60,332	52,757	36,080/8	62	19,172	...	5,630	100	...	...	10,305

The above table indicates the following significant indications.

(1) Out of 356 families only 62 families could bear the marriage expenses without incurring any debts for the marriage. The rest had to seek sowcars in order to have their sons and daughters got married.

(2) Out of the total marriage expenditure of Rs. 79,504, Rs. 52,757 were borrowed from the sowcars. This clearly shows that out of the total marriage expenditure nearly 69 per cent. of it was covered by debt.

The above state of affairs is not conspicuously true, only for the Untouchable classes. It can be generally applied to all the agricultural classes of the Bombay Presidency who, like the Untouchables, lack education, lack social stability, lack security for the debts they borrow, lack the permanent sources of income on which they can fall upon like some castes of the Untouchables. The result is obvious. They are equally degraded in their economic position and are equally susceptible to social traditions even at the cost of their economic stability.

INDEBTEDNESS

Collection of figures showing indebtedness of the Untouchables was a difficult task. I have found many cases where the borrowers themselves did not know the exact amount of their debt and in such cases they were naturally at the mercy of the money-lenders. In some cases I have found that they were not ready to expose their real position regarding their indebtedness, probably due to their sense of

prestige among their fellow-castemen. Some tried to overestimate it and others to underestimate it. But I have collected the figures with utmost precaution, verifying them from all possible sources and I can say, with confidence that on the whole, the figures that I have collected from the six Districts, are not far from the truth.

TABLE NO. 27.
(Showing the frequency and extent of debt.)

Amount of Debt	Mahar (No. of Cases)	Chamar (No. of Cases)	Mang (No. of Cases)	Dhor (No. of Cases)	Bhangi (No. of Cases)	Total (No. of Cases)
NIL	145	31	15	17	4	212
Rs. 1-100	141	24	11	2	6	184
" 101-200	53	15	1	4	1	74
" 201-300	23	11	3	1	1	39
" 301-400	8	3	1	1	1	14
" 401-500	4	2	...	1	1	8
" 501-1000	6	...	...	1	2	9*
" Over 1000	1	...	...	...	...	1
Total ...	381*	86	31	27	16	541*

It will be seen from the above table, that out of 381 Mahar families, 145 families, that is 38 per cent, are free from debt ; out of 86 Chamar families 31 families, that is 36 per cent. of them are free from debt ; out of 31 Mang families 15 that is 48 per cent. of them are free from debt and out of 27 Dhor families that is 61 per cent. of them are free from debt and out of 16 Bhangi families 4 families that is 25 per cent. of them are free from debt.

Paradoxical as it may appear, nearly 40 per cent. of these people are free from debt. That does not mean that these families are in better economic condition. But leaving aside hardly 5 per cent. of them who are in good economic condition, the rest are free from debt only because they are so poor and their credit is so low that no Sow-car would dare to lend them any money. For instance nearly 48 per cent. of the Mangs are free from debt only because, they have none or very little credit so that they find it very difficult to get any sum from the money-lenders and if at all they get, they get on very high terms of interest. On the other hand, the Bhangis who have got a permanent source of income by way of their monthly salaries, have good credit in the market, and they get even large amounts of debt on their personal security. That is why it is found that 75 per cent. of them are involved in debt.

* I could get no information regarding indebtedness of one Mahar family in the Kolaba District.

TABLE NO. 28.
(Average amount of debt per family.)
(in Rs.)

Caste.	Amount of Debt.*	No. of Families.		Average debt incurred.	
		Indebted.	Without Debt.	Per Indebted Family.	Per Family.
Mahar ...	35,021/8	236	145	148-4	91-9
Chamar ...	8,978	55	31	163-2	104-4
Mang ...	1,895	16	15	118-4	61-1
Dhor ...	2,775	10	17	277-5	75-0
Bhangi ...	3,346	12	4	278-8	209-2
.	52,015/8	329	212	158-1	96-1

From the above table we see that the Bhangis are more indebted than the other castes of the Untouchables and next to them are the Chamars. Both of them are economically slightly well off and they have better credit in the market.

From table No. 29 on the opposite page we see that the rate of interest charged, varies from 6 per cent. to 100 per cent ; but on an average it is $37\frac{1}{2}$ per cent. This high rate of interest is probably due to the absence of their credit in the market. The Mangs are paying on an average higher percentage of interest only because they have no security to offer for the debt they borrow, and the money-lenders naturally charge heavy rates of interest simply because they find it very difficult to recover their money. Taking the general of the situation it cannot be denied that these people are very much oppressed under the burden of their debt and this is one of the many obstacles in their way to better their economic condition.

THE SOCIAL GRIEVANCES

EDUCATION

The history of Village Education in India can be traced back perhaps to the beginning of the village communities, but the problem of education of the Untouchables came to the forefront only in the year 1854, when the British Government declared itself in favour of mass education. Before that period "there was never a question of admit-

* Figures relate to present debt.

TABLE NO. 29.

(Rate of interest.)

RATE OF INTEREST Per Cent	MAHAR		CHAMAR		MANG		DHOR		BHANGI	
	No of cases	Amount of Debt.	No. of cas.	Amt. of Debt	No of cas.	Amt. of Debt	No of cas.	Amt. of Debt	No of cas.	Amt. of Debt
1-5	2	375	2	300	...	...	...	...	...	...
6-10	9	1316	3	750	...	...	...	...	...	...
11-15	27	3117	6	736	...	...	2	1000	...	...
16-20	17	2435	7	1170	2	150	...	...	...	...
21-25	50	11664	11	2000	2	120	5	1425	1	325.
26-30	6	830	...	...	...	...	...	...	...	...
31-40	34	3609	5	725	4	440	1	150	6	1236
41-50	1	200	1	50	...	...	...	...	...	...
51-60	1	85	...	...	...	...	...	...	...	...
61-70	...	...	...	...	...	...	...	...	...	...
71-80	30	2370	5	495	3	180	...	...	1	500
81-100	1	175	1	25	...	...	...	...	...	...
101 and above	12	423/8	12	477	1	60	...	...	3	260
Rate not known	44	6682	11	2250	3	925	2	200	...	...
Without Interest	2	140	...	...	1	20	...	...	1	1000
Land Mortgaged	5	1600	...	...	...	...	...	...	...	...
TOTAL	241	35021/8	64	8978	16	1895	10	2775	12	3346.

ting them into the schools, as the education that was imparted, in the pre-British and early British days, was strictly confined to the higher classes. It was more or less a class education and naturally the Untouchables, who lay outside the regular caste system, had no chances of getting it as their mere touch would have been pollution."

It was only in the year 1856 that the question of admitting a depressed class boy into the Government School at Dharwar, was first raised. The Directors of the East India Company in their memorable despatch of 1854 had declared that "no boy be refused admission to the Government School or College on the ground of caste." But while

deciding this case of the Mahar boy, the Government of Bombay rejected his petition observing "the question discussed in the correspondence is of very practical difficulty. There can be no doubt that the Mahar petitioner has abstract justice in his side ; and the Government trust that the prejudices which at present prevent him from availing himself of existing means of education in Dharwar may be ere long removed. But Government are obliged to keep in mind that to interfere with the prejudices of ages in a summary manner, for the sake of one or few individuals, would probably do a great damage to the cause of education. The disadvantage, under which the petitioner labours is not one which has originated with the Government and it is one which Government cannot summarily remove by interfering in his favour as he begs them to do." ¹

Thus it will be seen that the right of the depressed classes to enter Government Schools was asserted in the despatch of 1858, but as a matter of fact "no effort was made for some years to enforce this theoretical right, and also very few separate schools were opened, so that in 1882 only 2,713 pupils of the depressed class population were in the primary school."²

The position of the Untouchables by 1882 was like this. "They had become alive to the advantages of education and in some places they were taking full advantages of the special schools established for them. The whole community was extremely poor but some of them were willing to pay the fees and thus they were trying to put forward their rights of getting admission to the schools."³

The difficulties of admitting their claims were both social and religious. Theoretically it was admitted beforehand by the Government in the letter dated 5th May, 1854, and again in their reply to the Government of India dated, 20th May, 1857, that "no boy be refused admission to a Government School or College merely on the ground of caste." Yet actually it became very difficult to get entrance into the private, indigenous, or to the Government Schools. Among the various reasons that were put forward by the caste Hindus the most potent was the fear of caste pollution. The Government nor the caste Hindus ever cared for their aspirations of rising high in the society. On the contrary total apathy was shown both by the Government and the caste Hindus to their anxiety for getting education as it will be seen from the statement of Mr. M. M. Kunte, some time acting Principal of the Elphinstone College, Bombay, that "the question of ad-

1. Government Resolution 1856.

2. Starte Committee Report, p. 13.

3. Hunter Committee Report, p. 513.

mission of children of Mahars and Dheds into the Government Schools is never raised by themselves. It is not real and has no practical bearing. It is a groundless agitation caused by sentimental English officials and unpractical Native Reformers."¹ But the fact that there were 3,512 Untouchable boys in the primary schools of the Presidency clearly shows that there was growing anxiety among the Untouchables to get education.

Another objection against their entrance into the Public Schools, was their "uncleanly habits and the unpolished manners and conversation of the boys." This might be true in some particular cases but it was not the universal reason for their non-admittance, as it can be seen from the incident that happened at Dharwar when the regimental school boys who were refused admission, were "neither unclean nor unpolished." But the fact was that there was a total absence of sympathy of the Government for their cause and it without taking the practical view of the problem, kept quiet, remarking that "there exists a deep-seated prejudice to the admission of the Untouchable boys into Public Schools and though its force varies in different parts of India, its existence is partly due to religious feeling and partly to fear of physical and moral contagion."²

So by the end of the nineteenth century the measures that were adopted by the Government to facilitate education for the Untouchables were two-fold. The first was that of establishing separate schools for them and the other was the extension of special encouragement to Missionary bodies to undertake their education. But this system became expensive owing to the difficulties of inducing any large number of boys to attend.

But none of these measures had touched the difficulties that were met in spreading education. "There might be the necessity of the separate schools but this measure admitted the principle of exclusion." "It intensified the difficulty when a clever student from this class wanted to enter the Secondary School or perhaps the normal school."

During this period stray individual attempts were made to spread Primary education among these classes. One of this type was made by a Christian Missionary at Ahmadnagar in the year 1855, by starting a separate school for them. But the first attempt was made by Jotiba Phooley, at Poona in the year 1848 by starting a separate school for these classes as "he had perceived the necessity of educating the class of people to whom his appeal was directed."³ In his

1. Evidence given by Mr. M. M. Kunte, before Hunter Committee, 1882.

2. Hunter Committee Report, p. 515.

3. "Caste and Race in India," By Dr. G. S. Ghurye, p. 166.

statement to the Education Commission of 1882 he has stated that "Government collects a special cess for educational purposes and it is to be regretted that this fund is not spent for the purposes for which it is collected. Nearly 9|10ths of the villages in the Presidency or nearly ten lakhs of children are without any provision whatever, for Primary instruction. The Mahars, Mangs and other lower classes are practically excluded from all schools owing to caste prejudices as they are not allowed to sit by the children of the higher castes. The special schools that are opened for them are only in large towns, for instance, in the whole of Poona, and for a population exceeding over 5,000 people, there is only one school and in which the attendance is under 30 boys."¹ Such was the state of affairs regarding the education of the untouchable classes by the end of the last century.

To-day we find that "the local authorities are trying their best to remove the disabilities. Generally no objection is taken by the parents of caste Hindus to their children sitting in a class room along with those of the depressed classes, and especially in big towns, there is hardly any distinction noticeable. It is only in rural areas where people are too orthodox that we come across some disabilities imposed on the depressed classes."²

The following is the analysis of my investigations :—

TABLE No. 30.

Districts.	Villages having Provision for Primary Education.		Villages having no provision of primary education.	Total No. of Villages.
	Where the untouchable boys are allowed to mix freely with other boys.	Where the untouchable boys are segregated in the school.		
1 Kolaba ...	13	10	10	33
2 Thana ...	16	5	8	29
3 Nasik ...	39	3	14	56
4 Satara ...	31	8	3	42
5 Ahmadnagar	28	1	2	31
6 Khandesh (East)	7	12	7	26
Total ...	134	39	44	217

1. A statement presented to the Hunter Committee by Jotiba Phoolley, Poona.

2. Report on Public Instruction in the Bombay Presidency, 1932-33, para. 108.

Thus we can see that out of the total number of 217 villages under survey, there are 44 villages where there is no provision for primary education. Out of the remaining 173 villages with primary schools, only in 39 schools the Untouchable children are not allowed to mix freely with the other children but in the remaining 134 villages they mix freely with the other boys and in no way are they treated with differentiation in the school premises.

WELLS

The question of wells is the most important and also the most difficult to solve. Nowhere have I found a common well used by the touchables and the untouchables, although from time to time, the Government might have issued orders, that all the public wells should be thrown open to all. There are many villages in Maharashtra where the Untouchables have no separate wells for their use and to them the problem of finding potable water becomes of intense difficulty, especially during summer when there is great scarcity of water. In such cases "they have to wait for the charitable among the caste Hindus to draw water and pour a little into their pots."¹ Thus they have to suffer intensely on account of scarcity of water. It "impairs both the health and their efficiency. Health suffers because the impure drinking water carries germs of guinea-worm which confine the patient to his home for several months."² Some of them, especially the agriculturists, have to suffer the economic loss by the waste of their time; for instance when they have to spend their time on their field is wasted on such a trivial operation as getting drinking water and lastly such "inadequate supply of water during the months (the hot months) when it is most required, cannot fail to affect health and vitality"³ of these classes.

We will now see the actual conditions of the six Districts that I have surveyed.

1. Starte Committee Report, p. 53.

2. "Some Village Studies," By Dr. G. S. Ghurye and Mr. S. G. Deshpande, p. 484. *Indian Journal of Economics*, Vol. VII, 1926-27.

3. *Ibid.*, p. 484.

TABLE NO. 31.

DISTRICTS	Villages having no provision for water in all the seasons of the year.	Villages having no provision for water in the summer season.	Villages having provision for water in all the seasons of the year.	Total Number of villages.
1 Kolaba ...	...	24	9	33
2 Thana ...	1	14	14	29
3 Nasik ...	...	16	40	56
4 Satara ...	2	15	25	42
5 Ahmadnagar	...	11	20	31
6 Khandesh (E)	2	12	12	26
* Total ...	5	92	120	217

Thus there are 217 villages in all that come under my survey and of these villages 5 villages are such that they have permanently no provision for water for the use of these classes. Out of the remaining 212 villages, where they have got provision for water, 120 villages are such that they get water in all the seasons of the year. But in the remaining 92 villages they find it very difficult to get it in the summer season. In 50 of these villages they have to beg water from the villagers, in 18 villages they bring water from long distances, in 20 villages they get water from rivers, etc., after digging, in 2 villages they buy it from the villagers, in one village in the Nasik District they employ a Maratha servant to pour it in the pots and in the remaining village in the Ahmadnagar District the local authorities provide a person to pour it in their pots.

GRIEVANCES AND THEIR REMEDIES

We have seen, so far, the social and economic disabilities under which the Untouchables are labouring. Various methods are suggested by people of all shades of opinion, to ameliorate their conditions, both economic and social, but in the following pages I have tried to analyse their own view-points, regarding their immediate sufferings and the way out of it. I had put a question in my questionnaire to elicit how their economic and social uplift can be done and the following is the analysis of their answers.

SOCIAL

(1) *Removal of Untouchability by Law* :—One hundred and sixty-nine families of all the different castes of the Untouchables from

the six Districts, under my survey, have suggested that removal of untouchability by law is the only solution that they can suggest to better their social and economic conditions. Out of these 169 families, 114 are Mahars, 34 are Chamars, 13 are Dhors, 7 are Mangs and one is a Bhangi.

(2) *Education* :—One hundred and fifty-two families out of which 132 families are from the Mahar community, 9 from the Chamar community, 10 from the Mang community and one from the Bhangi community have suggested that their salvation lies in the spread of education among them. It can be noticed from the above figures, that except Bhangis all other castes of the Untouchables have become alive to the spread of education. This fact can also be well noticed from the fact that out of 94 families who have suggested that the scholarships should be given to their sons and daughters to help them to take education, 65 are from the Mahar community, 8 from the Chamar community, 10 from the Mang community, 11 from the Dhor community and none from the Bhangi community. Some have suggested that compulsory primary education will help to spread education among them. Out of these 37 are from the Mahar community, 37 from the Chamar community, 11 from the Mang community and 12 from the Dhor community.

A very small number of these, have realised that mere knowledge of the three R's is not going to help much to solve their bread-problem and that some industrial education is quite essential for them, in order to have permanent stability in the society. Out of the 16 families who think in this way 10 families are from the Mahar community, 2 from the Chamar community, 2 from the Mang community and the remaining 2 from the Dhor community.

Only eight families out of which 6 are from the Mahar community, have suggested that hostels should be provided for their children. It is evident that the problem of hostels arises only in cities and towns where there are facilities for Secondary or Higher education. Such hostels may have many advantages in providing for "corporate life for the boys," but they have the grave drawback that "they do not mix the boys with those of the other castes."¹ However it is true that this problem of providing hostels, to the Untouchable boys, does not arise at all, in village education and it is needless to discuss here its merits and demerits.

There are 21 families from the Mahar community and one from the Chamar community who have suggested that they have been seri-

1. Starte Committee Report, p. 27.

ously handicapped on account of want of provision of primary education in their villages and that the immediate step that can be taken to better their condition is to provide schools for their villages. This is purely a local grievance but it can be seen that the Untouchables and more especially the Mahars have become alive to the need of getting facilities for education.

Five families from the Mahar community and one from the Dhor community have suggested that provision should be made for the higher education of their children. It can be well seen that the general population of the untouchable classes is absolutely incapable of understanding the importance or the advantages and disadvantages of higher education. It is only latterly that a small number of persons from the Mahar community have begun to realise the importance of higher education.

There are 19 Mahar families from East Khandesh District and one Mahar and one Chamar family from Kolaba District who suggest that the differentiating treatment of their children in the schools should be stopped and they should be treated on equal footing.

Lastly there are only 3 families of the Mahar community, one each from the Districts of Nasik, Thana and Ahmednagar, who have suggested that it will be of great advantage to them if they are provided with teachers coming from their own community. These people think that sufficient care is not taken of their children by the caste Hindu teachers but such grievances are very rare and as days pass on there will be no necessity for the Untouchables of having their own teachers.

(3) *Access of Wells and other Public Institutions* :—Twenty-four families from the Mahar community, one from the Chamar, and 5 from the Dhor community have opined that they have to suffer a great deal owing to the absence of provision for sufficient water for daily use. They have public wells in their villages but they have no access to them on account of their untouchability and according to them the immediate way for leading a better mode of life is to have free access to the wells and other provisions for water. Thereby they feel sure that they can lead a better and cleaner way of life and they will have free association with the caste Hindus which will be beneficial to them to change their dirty ways of living.

While there are other 25 families 18 from the Mahar community and 7 from the Mang community who are suffering on account of intense scarcity of water, feel that anyhow immediate steps should be taken for the provision of water for their daily use. They are not very much keen on having access to the common wells but they want only their difficulty in getting water to be solved.

There are 4 families from the Mahar community and 2 from the Chamar community who complain that they are occasionally cheated by the shop-keepers, who give them the worst type of articles and as they are not in a position to make a choice of the articles by selecting with their own hands that they have to buy on account of their untouchability, they have no other alternative but to accept the articles which the shop-keepers offer. Thus they are greatly handicapped and they feel that it would be of great advantage to them if access to the shops is facilitated.

There is only a solitary case from the Kolaba District where one family of the Mahar community complains that they are not allowed to travel by Motors or by Tongas on account of their untouchability. But this seems to be a very rare case. It is noteworthy that only thirteen families out of which 10 from the Mahar community, one from the Mang community and 2 from the Dhor community have expressed their desire to have an entry into the caste Hindu temples.

(4) *Carriion-Eating*. Five families, three Mahars, one Chamar and one Dhor have expressed that carrion-eating should be prohibited by law with a view to better the sanitary conditions of the untouchables and to have free association with the caste Hindus. It must be remembered that the Untouchables on the whole abhor publicly carrion-eating. They are denouncing it in public meetings and their leaders and those who are working for their salvation are preaching them to take a vow not to eat carrion.

Two Chamar families from Kolaba District have complained that they are greatly harassed by the Kumbhars, who work as their priests for the death ceremonies. Generally the Chamars engage the Brahmins as priests for their marriage ceremonies and the Kumbhars for the death ceremonies. Though this seems to be purely a local grievance, yet it gives us an idea of the complex nature of the problem of the Untouchables.

ECONOMIC

(1) *Government Service*. Seventy-four families, out of which 57 are Mahars, 10 Chamars, 2 Mangs and 5 Dhors have suggested that Government service to their qualified candidates is the best course for them to better their economic and social condition.

(2) *Uncultivated Land*. One hundred and thirty-four families out of which, 24 are Mahars, 3 Chamars and 7 Mangs have expressed their opinion that they would gain economic independence much earlier, if they acquire lands from the Government which are lying uncultivated, on a nominal rental fee. The problem is of vital importance

as most of them who are depending upon agriculture do not possess their own land and are simply agricultural labourers. Especially the Mahars are greatly affected by it, as a large number of them are depending upon agriculture or agricultural labour, having no other occupation of their own, like the Chamars or the Bhangis.

(3) *Debt with low interest.* Sixty-one families, out of which 41 are Mahars, 11 Chamars, 6 Mangs and 3 Dhors have suggested that they are suffering intolerably under the heavy burden of debt and there is no ray of hope for them unless they are offered money at low interest.

(4) *Co-operative Credit Society.* In the field of economic upliftment co-operative societies are essential as an ameliorative agency. Thirty-four families out of which 11 are Mahars, 6 are Chamars, 6 Mangs and 11 are Dhors, have suggested that the establishment of co-operative credit societies will help them much to improve their economic conditions. They can revive the industries that are in their hands such as shoe-making, leather-tanning and rope-twisting, etc.

(5) *Miscellaneous.* (a) Sixteen families out of which 10 are Mahars, 2 Chamars, 2 Mangs and 2 Dhors have suggested that the accommodation of space for their houses is too small and that they have to live in the most insanitary conditions. In the villages we find that "the castes are allotted district quarters of the village and called by the name of the caste; Brahmin-ali or wada, Prabhu-ali, Sonar-ali, etc,"¹ and "the depressed classes like the Mahars and the Mangs, etc., are forced to live on the outskirts of the village."² Often the space allotted to these people is dirty and too narrow with the result that they have no other alternative but to stay in such dirty places. In several villages in the East Khandesh District the Mahars have made a complaint that adjoining their houses, in the village, they have got the houses of the Dhors who carry the tanning work and thereby they are put to much nuisance on account of the dirty smell. In some other villages they have stated that they have not sufficient accommodation for disposing the dead animals and are left to decompose in the vicinity of their houses. The natural result is that these people are compulsorily forced to live in unhealthy and insanitary places and are given no opportunities to appreciate the cleaner ways of life.

1. "Land and Labour in a Deccan Village," Study No. 2, By Dr. H. H. Mann, p. 108.

2. "Caste and Race in India," By Dr. G. S. Ghurye, p. 11.

(b) *The Vatan System.* Eight Mahar families have suggested that they are convinced that the Vatan system is one of the chief causes why they are kept in backward condition. The whole system is oppressive to the Mahars. In the first place the duties of these Mahar Vatandars are not defined. "It is not known, in fact nobody as a matter of fact, can say to what particular department these vatandar Mahars belong. As a matter of fact every department claims their services."¹ They have to be ready at all times and in case the vatandar has to go on his personal work even for a day he can do it only when he gives a substitute for him. The remuneration that they receive in return is insufficient for their work. For instance, as I have mentioned elsewhere "in Thana District the amount paid by Government directly to the Mahar Officiator comes to Rs. 1|8 per month ; the amount paid in the Ahmadnagar District comes to Rs. 1|8 per month."² In fact nowhere in Maharashtra do they get more than Rs. 1|12 per month. The additional income that these people get is the Baluta. But as I have remarked it goes very difficult for these people to collect the Baluta in these hard days. The Inam lands that they possess are so sub-divided that they practically yield no income. So in no way is the Vatan system beneficial and it really, as Dr. Ambedkar told the other day at the Bhor Conference that it is the Mahar Vatan that comes in their way of upliftment of the Mahars and the sooner they get rid of it the easier is the way to their salvation.³

(c) *Forced Labour.* Four Mahar families have suggested that they have to do forced labour for the Government Officials as well as for the villagers, with no remuneration. The result is that at times they have to suffer economic loss as days after days are wasted in such sort of forced labour. The practice is essentially an outcome of the Vatan system and it only affects the Mahars and at times the Mangs. The duties of the vatandar Mahars are not defined with the result that sometimes petty officials ask them to render personal services and do such work which has in no way any connection with their official work. Generally they are required to work as message bearers of all Government officials, high as well as low, travelling in the Districts ; but at times they have to carry grass for their horses and other domestic animals, bring firewood for them, clean and sweep compounds and do all sorts of work that may be required.

As a part of the vatan system, they have to render some services to

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1. Bombay Legislative Council Debates, Vol. XXIII, p. 709.
 2. Bombay Legislative Council Debates, Vol. XXIII, p. 710.
 3. "Dnyan Prakash," (Marathi), dated 9th January, 1935.

the villagers. For instance they have to remove dead animals from the villages and sweep and clean all refuse in the village. They have also to inform their relatives in other villages at the times of weddings and funerals, and in short they have to be at the beck and call of the village Patil and Kulkarni at any moment. In some places I have found that they are refusing to work for the villagers and consequently they have to suffer a great deal on account of the social boycott of the villagers. Recently a case happened in village Tudil, Taluka Mahad in the Kolaba District where the Mahars refused to remove the dead animals and consequently they are under social boycott of the Mohammaders who are the residents in predominant number of the village and who are also the Inamdars of the village. They have taken the lands given to the Mahars for cultivation and even have gone to the extent of stopping the water supply given to them. This is the usual result of their refusal to work for the villagers and unless they are very large in number in the villages or they are sufficiently self-reliant they dare not refuse to work as required by the villagers.

(d) *Advice to Untouchables.* Two Mahar families and one Chamar family have stressed that in order to bring about their social and economic upliftment, the caste Hindus should make a point to associate with the Untouchables oft and on, and should make them understand the importance of cleanliness and good habits.

CONCLUSION

We have discussed so far, the social and economic conditions of the Untouchables in Maharashtra and we have also seen how these circumstances stand in the way of their uplift. Thus we can very easily visualize that in order to assimilate the untouchable classes into the Hindu society we require, "first there is the immediate need of removing the disabilities that actually hamper the development of the individual by acting as hindrances in the way of better and a cleaner living. Second, to enable these classes to appreciate a cleaner and more moral mode of life. Third, to accustom the members of other sections to a freer social intercourse with these people and lastly to undermine and eradicate the exclusivist spirit of caste."¹

We have seen that the two important disabilities that actually hamper them are the lack of proper provision for water and facilities for education of their children. They generally find great difficulty in getting an ample supply of fresh water, because where separate wells for their use do not exist, and in some villages if at all they

1. Dr. G. S. Ghurye, "Aryan Path," Feb. 1933.

exist they are in very much insanitary conditions and they go dry in the summer season, there is always great trouble in getting water for their daily use, as they are not allowed to take water from the public village wells. This is really a serious handicap in their way of living a cleaner life and it also involves great amount of time in getting water for drinking purposes. It is essential that they must be made to appreciate a cleaner mode of life and this will be done only when there is ample provision of water for their daily use.

The second handicap under which they are labouring is the want of facilities for education. First it must be remembered that they have not cultivated to a great extent, a desire for education and special attention is required for making them understand the importance of education in the daily life. There are many difficulties in their way in sending their children to the schools. In some village schools they are not allowed to mix fully with the children of the other caste Hindus. In some places the teachers are found not much careful about the studies and clean habits of these children and I have found many cases in several villages where the untouchable boys have to spend two or three years in order to finish the first standard of the schools, with the result that most of these boys leave the schools before entering the second standard and in spite of their attendance in the schools for two or three years, they get no knowledge of the three R's and they are as bad as the other illiterate boys. So mere provision of schools in the villages will be never of full use to the upliftment of these classes unless they are made to realise the importance of education and they are helped in every way possible to remove the actual difficulties that come in their way in sending their children to the schools. Moreover, special attention is essentially required to see the progress of the Untouchable boys in the schools and such cases should be brought immediately to the notice of higher educational authorities where these boys are deliberately neglected by the teachers.

Thus we can see that concentration is essentially required on the primary object of securing full civic rights for the Untouchables, as the right of drawing water from the public wells if they have no wells in good conditions and of sending children to public schools, without any discrimination being exercised against them. This will lead to help these classes to appreciate a cleaner and more moral mode of life. Really there are many villages where the caste Hindu villagers have better provision of water in their villages, in all the seasons of the year, but unfortunately the Untouchables in those villages are put to severe handicaps in getting water for drinking and washing purposes and in such circumstances it is highly essential

that special efforts should be concentrated in all directions, under any cost, to see that these unfortunate classes also get sufficient provision of water. Otherwise all our efforts and good wishes to see that "they appreciate a cleaner and more moral mode of life" will be of no use as long as we have not removed these handicaps that are in their way. In village schools also there must be an attempt made by the school authorities that in addition to the knowledge of simply the three R's, there must be created opportunities of imparting discourses on the proper ideals of life, of cleanliness and morality and opportunities should be created and handled in such a way that these classes come in immediate contact with ideas of better and cleaner way of life which will help to effect a change in their social environment. This, of course, will be successful only when it is done purely in a Missionary Spirit.

The third thing that is essentially required for changing their outlook on life and making them realise to lead the right sort of moral and religious life is "to accustom the members of other sections to a freer social intercourse with these people." This will partly be done as I have stated above, in the villages where there are primary schools, if they are run in the Missionary ways that I have suggested. But this much attempt is not sufficient when we have to see that a change in the outlook of the Untouchables as well as of the villagers is required and besides there are many villages without the primary schools and so it will only be possible when opportunities are created in the villages where the Untouchables as well as the caste Hindus, assemble together for "Bhajans, Kirtans, and Pravachans together." This will not be possible, all of a sudden but special attempts should be directed in this way, with a small beginning such as assembling together on special religious days as Dasara, Sankrant, etc., on which days the Reformers as well as those who have taken the responsibility of eradicating Untouchability, should try to see that freer intercourse between these two sections of the society is gradually made, without any trouble. This really requires careful handling on the part of the Reformers and it will be possible only when it is done, with disinterested motives, with real anxiety for their salvation and with love and sympathy for these people for their hard lot.

But all these three things will be possible only when an attempt is made side by side "to undermine and eradicate the exclusivist spirit of caste." "For Untouchability is only a flagrant manifestation of the spirit of caste. The principle which runs through the whole caste system, breathes the spirit of exclusiveness, lays down barriers between group and group and culminates in the position of various social and religious disabilities on the lower sections. Viewed thus, Untouch-

ability registers the highest degree of spirit of caste. Removal of Untouchability therefore, immediately depends on the disappearance of the spirit of caste."¹ This spirit of caste differentiation is not only among the caste Hindus but it is also equally formidable among the Untouchables as it can be seen from two recent incidents, one at Sholapur and the other at Sawantwadi. At Sholapur there is a long-standing dispute between the Mahars and Mangs of Vairag, a village in Barsi Taluka, regarding their right to draw water from a well, where the Mahars are asserting their sole right on the alleged caste inferiority of the Mangs and the Mangs in return asserting their own superiority over the Mahars.² The other incident which took place at Sawantwadi is that one social Reformer invited all the castes of the Untouchables on the Sankrant day and he wanted to distribute Tilgul to all of them, without observing any untouchability. This enraged some of the Mahars as they were not ready to touch the Chamars, with the result that the whole function ended without the achievement of the real object.³ Thus it will be clear that the whole Hindu society is based upon the exclusivist spirit of castes and what is essentially required is to wipe out such spirit by which the castes are differentiated and not allow any scope for functions which are likely to tend such exclusivist spirit. Nay, on the contrary, the Reformers should try their level best to substitute such functions by other functions so that caste patriotism and caste exclusiveness will be of no or of very insignificant importance and there will be an atmosphere, where the people have assembled for a common purpose, for common utility and for common salvation for all, irrespective of their castes.

These four things will be possible only when there is a central organisation to fight Untouchability with a net of smaller Committees all over the country. There must be Provincial Committees. Each Provincial Committee should appoint a small number of persons who are sympathetic and who sign a pledge that "they will work for the removal of Untouchability, at least in every Taluka town to carry on the programme outlined by the Central Organisation."⁴ These organisations will have to have an army of workers in the rural parts who will encourage the Untouchables to get their rights redressed by persuasion or by any other polite means possible. They should see that

1. Dr. G. S. Ghurye, "Aryan Path," Feb. 1933.

2. "Times of India," dated 16th Jan. 1935.

3. "Subodha Patrika," dated 27th Jan., 1935.

4. Dr. G. S. Ghurye, "The Aryan Path," Feb. 1933.

"cases of bad treatment of Untouchables or of refusal to admit their children to common schools, differential treatment in Government or in Municipal Dispensaries are some of the grievances which they should try amicably to settle by private and personal negotiation and persuasion. Failing such polite remedies, the Committee should communicate with the civil authorities of the place and also inform the Provincial Committee about the incidents. The Provincial Committee then may decide upon legal action or may confer with the higher civil authorities." ¹ Thus "Untouchability is a sin done by us and we must be interested in their cause for the sake of purifying ourselves of the taint of Untouchability and doing penance for the sin." ²

Finally, this is a question of national self-interest and it will not be possible for us "to realise our National aspirations" nor "our country can ever hope to make her place among the Nations of the world." "It is to be remembered that National decline has its origin in the oppression of others, and if we Indians desire to achieve National self-respect and dignity, we should open our arms to our unfortunate brothers and sisters of the depressed classes and help to build up in them the vital spirit of human dignity. So long as we have these large classes of the Untouchables in this country, we can make no real progress in our national affairs, for this requires a high moral standard; and this is unthinkable where the weaker classes are unfairly treated." ³

"This work is bound to be slow and can only be achieved by strenuous exertions for giving them education and finding for them honourable employment in life. And it seems to me that, in the present state of India, no work can be higher or holier than this. I think that if there is a question of social reform more than another that would stir the enthusiasm of our educated young men and inspire them with an unselfish purpose, it is this question of the degraded condition of our low caste. What the country needs most, at the present moment is a spirit of self-sacrifice on the part of our educated young men and they may take it from me that they cannot spend their lives in a better cause than raising the moral and intellectual level of these unhappy low castes and promoting their general well-being." ⁴

M. G. BHAGAT.

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1. Dr. G. S. Ghurye, "The Aryan Path," Feb. 1933.
 2. Mahatma Gandhi, "Harijan," dated 20th April, 1934.
 3. Lajpat Rai, "The Arya Samaj," p. 232.
 4. G. K. Gokhale, *His Speeches and Writings*, pp. 901-902.

Notes

FIVE VALA COPPER PLATE GRANTS

[NOTE :In Vol. III, Part I of the University Journal there appeared a paper on Five Vala Copper-plate grants, submitted by Mr. A. S. Gadre, M.A., Mr. Dines Chandra Sarkar, M.A., Premchand Roychand Student, Calcutta University, has submitted a note thereon and the note is published below together with the reply of Mr. A. S. Gadre.]

NOTE OF MR. SARKAR

Mr. A. S. Gadre has edited five copper-plate grants, found in the course of excavations in Vala, in a paper which was originally read before the first Bombay Historical Congress in 1931 and has now been published in the *Journal of the Bombay University*, Vol. III (July 1934), pp. 74-91. I have carefully examined Mr. Gadre's reading of Grant I which belongs to the Garulaka Maharaja Varahadesa and is dated in the Gupta year 230 (—A.D. 549). There are unfortunately several mistakes in the reading of the inscription.

1. The last word of line 1 has been read as (a*) tula ; the facsimile however clearly shows kula.

2. In line 9, Mr. Gadre reads *gunabhusanam-Krtata- yuga*, and suggests in a foot-note to correct the passage as *bhusanah Kr*. The *m*-like symbol above *K* in *Krta* is undoubtedly a *jihvamutrya* and *Krtata-yuga* is obviously a misreading for *Krta-yuga*.

3. In line 15, Gadre has read *yath- asminn- eva sammikraste* where the word *valabhi* has been omitted before the last word which is to be read as *Sammikrste*.

4. In line 22 has been read *paripala- yitavyas-c-eti*. The correct reading however is undoubtedly *paripalayitavyas- ca*.

I am afraid, there are also inaccuracies in the reading of the other four grants, (e.g., see line 26 of Grant IV where *dayo* has been wrongly read as *dayataya*). It is, therefore necessary to request Mr. Gadre to correct the inaccuracies that have unfortunately crept in his reading of the "Five Vala Grants."

MR. GADRE'S REPLY

It gratifies me to note that scholars like Mr. Sarkar are taking interest in such articles and indeed the object of publishing facsimiles,

for the benefit of students of Indian Epigraphy, is fulfilled. I myself was aware of some misprints in the text which were mostly due to inexpert proof-correcting and also to the fact that the text sent to press was a copy made from my original MS. by my clerk. I had read the grants from the original plates and not from the facsimiles. Though the original plates are in a very bad state of preservation, the blocks of the facsimiles are indeed very nicely executed and do credit to the printers. In some places indistinct letters in the original become distinct in the prints, e.g., in I. 17, II. 3, II. 24. In others what was clearly traceable in the original is seen indistinctly in the copy, e.g., II. 2, II. 12, 13. In the facsimiles some vowel marks and *anusvāras* though faintly traceable in the original cannot be seen. Thus many of the so-called misreadings can be accounted for. Besides the misprints are too insignificant to take notice of. Such misprints do occur even in the standard journals. As the corrections are mostly obvious and do not alter the text, I hesitated to send a list of corrections which I would surely have volunteered myself long before if the misprints had been serious. Still as a scholar like Mr. Sarkar has taken notice of them, and as the Registrar has requested me to give an explanation, I send the following corrections. I very much regret even such small errors should have crept into a piece of work which surely was expected to be as perfect as possible.

In the following corrections I have used the Roman script for transliterating. The Roman figures stand for the grants published in B. U. Journal, Vol. III, pt. 1 and the ordinary figures indicate the lines in each grant.

- I. 1. I still hold my original reading *varṁśetula*. Mr. Sarkar's reading of °*kula*° for °*tula*° gives no meaning and is not in conformity with the text of similar phrases in other grants. This so called *ku* may be contrasted with the same letter to be found three times in line 13 of the same grant.
- I. 7. Read *śra(i)ta* for *śrita*.
- I. 8. Read *g(ś)ri* for *śri*.
- I. 9. Read *bhūṣaṇaḥ-kṛita* for *bhūṣaṇamkṛitata*.
- I. 15. Insert *Valabhi* before *sannikṛishṭe*.
- I. 17. Read *dakṣiṇena Gokshi* for *dakshi[ṇena Go]kshi*.
- I. 21. Read *sāmānyam* for *sanmānyam*.
- I. 22. Read *paripālayitavyaś = cha* for *paripalayitavyaś = ch = ēti*.
- II. 12. Read *[tā dharmma-dā]yānām* for
tā dharmmadāyānām.
- II. 13. Read *[t-ārāti-pa]ksha* for *t-ārātipaksha*.
- II. 28. Read *varṁśajair = anyair = v = ānityāni* instead of *varṁśajair = anyair = vā anityāni*.

- III. 1. Read *Maitrakāṇām* (ṇā) *m*=*atula* for *Maitrakāṇām*=*atula*.
 III. 6. Insert *dhairya* after *sthairya*.
 III. 10. Read °*gāmikair* = *guṇaiḥ* for *gāmikair* = *gguṇaiḥ*.
 III. 21. It may be even read Yaksha-śu (ū)rā as the facsimile would show.
 III. 24. Read *Amadāsa-putra* without brackets.
 III. 27. Read *kshiti* for *kshitti*.
 III. 29. Delete *cha* after *Sāmānyam*.
 IV. 15. Read °*pīṭho* for *pīṭho*.
 IV. 25. Read *kshitissa(sa)rit* for *kshiti-sarit*.
 IV. 26. Read *dāyō* for *dāyatayā*.
 V. 26. Read *ssa(sa)chcharitā*° for *sañchāritā*.
 V. 31. Read *prāśamī* for *prāśēmī*.
 V. 35. Read °*taila-nimittāya* for *tail-ādy-arttham*.
 V. 43. Read *svargge[t]ishṭhati* for *svargge[modēta]*.

Reviews

Law and Justice in Soviet Russia. By H. J. Laski. (Hogarth Press, 1s. 6d.) London, 1935.

The Hogarth Press has done valuable service in asking Prof. Laski to contribute to the "Day to Day Pamphlets" one on Law and Justice in Soviet Russia. It is a well written account by one who is a foreigner to Russia of some of the characteristic features of the administration of law and justice in the Soviet Republic. The most interesting part of this popular leaflet is the chapter on Prison treatment and Reform in post war Russia. To most people the word justice ordinarily suggests the ideas of law and punishment. Civilised man is still obsessed by the retributive theory of punishment—an eye for an eye, a tooth for a tooth. We have been for the last hundred years busy with the work of prison reform and plans for improving the machinery of Criminal Law and Procedure. We have sometimes forgotten that the conditions that governed criminal procedure and the treatment of prisoners are a reflection of the general moral standards that are operative amongst us. As Housman has observed "We cannot afford to humanise our prisons, while we will not afford to humanise our slums." It has been reserved for Bolshevich Russia to experiment on more human principles in the matter of prison reforms and the treatment of criminals. The account of prison life in Russia that Prof. Laski gives calls for attention. He observes that the principle that, as Society is to be regarded as partially responsible for crime, the object of punishment should be reform, has had remarkable consequences in the social life of the Bolshevich Republic more or less unknown in other countries. Amongst the consequences he says, "The first is the direct interest of the judiciary in the penal system. The second is the insistence that the prisoner must lead a full and self respecting life from which the inference is drawn that, since work is the basis of self respect, the prisoner must work for wages at tasks similar in character to those of normal industry. The third is the high degree of self-government characteristic of Russian prisons.... The final principle is the effort, through the creative organisation of leisure, to prevent that deterioration of character which seems so frequent in normal prison population through deprivation of the habits and opportunities associated with normal social conditions."

Laski describes prison life in Russia in some detail. All prisoners do normal industrial work and receive wages. They have the right to a vacation. They receive visitors. There is no censorship on the letters that they write and receive. They can smoke when they are not working. They are not prevented from talking with other prisoners or with the warden. The use of leisure by the prisoners is considered as vital as the use of the working day. Wireless, classes in cultural and vocational subjects, gymnastics, books, dramatic performances, concerts both for and by the prisoners, a prison newspaper are all universal features of prison life. Some attend classes at the University and go to and fro with no fear of their running away. "The impression" says Laski, "I had was the quite definite impression that those with whom I talked would return to the world far more fitted to cope with its problems than before. They had not been disciplined into machines. They had learnt the value of regular labour. They had not been made to feel that they were cut off from the outside world."

Bolshevik Russia has been often looked upon, even by those who have made an honest endeavour to follow sympathetically the new experiments in social living, like Mr. Stanley Jones for instance, as anti-religious and anti-Christian. Let us remember that it is a Christian society as represented by the civilised nations to-day that is used to the methods of solitary confinement and the silence rule in prison life, that seeks to break the will of prisoners with the help of Christian chaplains, and endeavours to sanctify its un-Christian treatment of prisoners by supplying religious instruction to them through sermons and tracts. It has been reserved for an anti-Christian government like that of Russia to experiment on Christian lines and to treat the criminal as a personality with intrinsic worth and calling for human treatment even when he is driven into unsocial or inhuman actions. The disappointing fruits of our penal code and prison administration are a striking evidence to the working of nemesis. "With what measure ye mete, it shall be measured to you again." It has been reserved for Bolshevik Russia to insist that even the worst criminal should be treated as an end in himself, and with a view to his future restoration to a life of useful citizenship, to act upon the belief that we have no right to sit in judgment upon a fellowman, to recognise our corporate responsibility in the making of the criminal, and to build a system of institutions which recognise the intrinsic worth of every human soul.

P. A. WADIA.

Race and Economics in South Africa. By W. G. BALLINGER. (Hogarth Press, pp. 67. 1s. 6d.) London, 1934.

The pamphlet under review is a valuable addition to the series of Day to Day pamphlets through which the Woolfs are trying to concentrate public attention on some of the most important problems confronting the world to-day. The writer Mr. W. G. Ballinger has been in South Africa since 1928 working as Technical adviser to the African Trade Union movement and can therefore claim the authority of intimate personal knowledge of conditions affecting the natives of South Africa.

According to the census of 1931, South Africa had a population of 1·8 million Europeans as against a population of 4·7 African natives. It is interesting to note that the natives have either in tribal or private ownership only 9 per cent. of the land of the Union ; while the other nine-tenths is either in European ownership or is reserved for European ownership. The Colour Bar Act of 1926 excludes natives from skilled and semi-skilled occupations on the mines while the operation of the Masters and Servants Acts which render Trade Union activity illegal for natives, and the exclusion of the natives from the operation of the Wage Act and the Industrial Conciliation Act have the same effect. The Apprenticeship Act of 1922 operates in the same direction, since in practice the inclusion of an education qualification for an apprentice rules out natives for whom educational facilities are not provided. It is estimated that at the present time 1,100,000 native children are receiving no education whatsoever ; for the 300,000 who are being educated the sum of £2 3s. 6d. per capita is spent by the state, as against the sum of £25 13s. per capita for the 384,000 European children for whom education is provided. It is not only legislative enactment specifically designed to control his economic freedom which closes the road to advancement for the native ; that road is also barred by the operation of the pass laws, *e.g.*, in the Transvaal, every native has to carry at least three documents always in his purse, his labour service contract or monthly pass, his poll-tax receipt, and his travelling pass ; if he move abroad after 10 p.m. a night special pass must also be carried. Failure to produce any one of these on the demand of a police officer means immediate arrest. Needless to say these vexatious obstacles to economic and social improvement produce irritation ; but the expression of this discontent is rigidly controlled by the operation of the Riotous Assembly's Act which does not discriminate between agitation for better conditions of living and sedition and tends to identify the expression of native grievances with incitement to ill-feeling between black and white, which is an offence punishable by banishment. Politically, of course, the policy of differentiation

finds full expression. In the Transvaal and the Orange Free State the native is not eligible for the franchise. In the Natal his eligibility is subject to a large number of restrictions while even in the traditionally liberal Cape Town Province the native no longer enjoys even on paper the same conditions for eligibility to the franchise as his European colleague. The South African Senate contains 4 nominated members who are supposed to reflect the reasonable wants and wishes of the coloured races of South Africa. But it is significant that the four special senators have counted for nothing in the history of the stream of legislation which since 1911 has raised one barrier after another to the economic advance of the native. The Permanent Native Commission appointed under an Act of 1920 to advise Government on matters affecting natives has been quite disappointing and European and native alike tend to regard the Commission as a department of the Government in power rather than as an independent body entrusted with the safeguarding of the future of the native. The same Act of 1920 provided for the summoning of an annual conference of native persons and bodies representative of native opinion to discuss proposed legislation affecting natives ; but it may be noted that actually it has not been summoned every year. Provision is made for the residential segregation of natives within the Urban areas, while there exist in rural areas large native reserves. In these areas some attempt is made to provide a medium for a degree of self-government by making provision for the establishment of local councils. In the largest of the Union's native reserves, the Transkeian native territories, there exist not only local councils but a central council or somewhat misnamed as Parliament commonly known as the Bunga. It may be noted, however, that as regards native advisory boards in towns as well as native advisory councils in rural areas official chairmanship stultifies discussion and prevents these institutions from being real training centres for self-government. Even the Bunga has the chief magistrate as chairman and its recommendations are subject to revision by a magistrates' council.

Against this background the author presents a fascinating economic problem in progress. The town wanted cheap industrial labour while the country-side wanted to retain the natives to work its farms. This economic fact accounted to some extent for the antagonism between the predominantly English speaking and industrialist Urban South African party as against the Dutch speaking predominantly rural Nationalist party. Now, however, the position is changing. The economic depression and changing times have resulted in many a European skilled worker falling into the ranks of the unskilled ; while technical progress which makes for increasing substitution of

skilled by unskilled worker and the peculiar fitness of the African native for aiding in mass production are both menacing the white workers of the towns with the competition of the low-paid African native. At the same time it is obviously impossible, despite the sentimental strength underlying racial prejudices, to replace the present African employees with whites who would expect a very much higher payment ; nor is it possible to do away with the 4·6 millions of natives who form the predominant population of the Union. Moreover, the dominant industry of the Union is gold mining and with the uncertain future of gold, South Africa might at any moment be forced to look to the exploitation and sale of its resources within itself for its living. Under the circumstances it is evident that the solution lies in a rise in the standard of life of the African workers, the removal of the obstacles that prevent their economic advance, and the formation of a labour party and of trade unions which will include both white and coloured workers. Whether such a solution will eventually be reached or whether the future has in store for the Union a violent upheaval that might shake its economic, political and social structure to its foundations is more than what one can attempt to prophesy. At any rate the pamphlet under review is both interesting and thought-provoking and needs study particularly by readers in this country who in their pre-occupation with their own grievances do not seem to pay much attention to the much more distressing and perhaps more hopeless problem of the South African native.

V. K. R. V. RAO.

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PART II

CONTENTS

TRANSACTIONS

MOVING AXES FORMULÆ IN THE n -DIMENSIONAL SPACE	G. S. MAHAJANI	3
A CHAIN OF THEOREMS RELATING TO COLLINEAR AND CONCYCLIC POINTS	A. RANGANATHA RAO	11
RESISTANCE OF A GENERAL ELLIPSOID MOVING IN A VISCOUS FLUID	D. K. SEN	14
THE RECESSION OF THE SPIRAL NEBULÆ	K. V. SASTRY	19
A NOTE ON THE UNDISTURBED PLANETARY MOTION	D. R. SHARMA	21
A SIMPLIFICATION OF EINSTEIN'S EQUATIONS	DEODHARY RAI SHARMA & V. V. NARLIKAR	22
TRANSMISSION OF VISIBLE LIGHT THROUGH ARTIFICIAL HOMOGENEOUS CLOUDS	G. R. PARANJPE & N. N. BHAGWAT	28
IRON ARC SPECTRUM IN THE INFRA-RED	N. R. TAWDE & V. S. PATANKAR	65
THE TRACKS OF SWIFT NUCLEI IN PHOTOGRAPHIC EMULSIONS	H. J. TAYLOR	70
ON THE NATURE OF CHEMICAL BINDING OF CERTAIN OXIDES AND SULPHIDES	P. K. SEN-GUPTA	74
ON THE THEORY OF VISCOSITY OF LIQUID METALS	D. V. GOGATE	83
ON THE MAGNETIC MOMENT OF THE NUCLEUS AND HYPERFINE STRUCTURES IN THE SPECTRUM OF DOUBLY IONIZED ANTIMONY WITH A NOTE ON THE STRUCTURE OF THE ARC LINE λ 3723	J. S. BADAMI	86
A STUDY IN THE DEGRADATION TO SUCCINIC ACIDS THROUGH γ -BUTYRO-LACTONES AND OTHER REACTIONS OF β -ANISYL AND β -HALOGEN ANISYL GLUTARIC ACIDS ...	DATTATRAYA BALKRISHNA LIMAYE AND RAGHUNATH GANESH CHITRE	94

A NOTE ON THE CONDENSATION OF ETHYLENE CHLORHYDRINE WITH RESORCINOL ... D. C. MOTWANI AND T. S. WHEELER	104
A NEW METHOD FOR THE SYNTHESIS OF α -SUBSTITUTED GLUTACONIC ACIDS ... NAGESH LAXMAN PHALNIKAR & KRISHNA SHRINIVAS NARGUND	106
C-ALKYL RESORCINOLS. I.—4:6-DIETHYL RESORCINOLS AND ITS REACTIONS ... R. C. SHAH & P. R. MEHTA	109
INTERACTION OF SELENIUM OXYCHLORIDE WITH THE SUBSTITUTED AMIDES OF MALONIC ACID ... R. K. TRIVEDI	114
SYNTHETIC PRODUCTION OF CAMPHOR FROM PINENE—PART II B. G. S. ACHARYA & T. S. WHEELER	118
VISCOSITY MEASUREMENTS DURING THE COAGULATION OF TITANIUM DIOXIDE SOL BY MIXTURES OF ELECTROLYTES AND NON-ELECTROLYTES MISS OLIVE JOSEPH & S. M. MEHTA	123
THE METHODS OF MEASURING SURFACE TENSION C. C. PATEL, K. V. DESAI & S. M. MEHTA	132
COAGULATION OF DILUTE OIL EMULSIONS BY MERCURIC CHLORIDE: EVIDENCE FOR THE DISCONTINUITY OF THE CHANGE IN THE SLOW REGION SHRIDHAR SARVOTTAM JOSHI & SHANKAR PRASAD SARCAR	140
CHEMICAL INVESTIGATION OF THE SEEDS OF HYGROPHYLLA SPINOSA NAGESH LAXMAN PHALNIKAR, KRISHNA SHRINIVAS NARGUND & DORAB DINSHAH KANGA	146
CONDENSATION OF PHENOLS AND PHENOLIC ETHERS WITH ACETONE DICARBOXYLIC ACID—PART II: β -SUBSTITUTED CYCLOBUTENONE CARBOXYLIC ACIDS. VINAYAK MAHADEV DIXIT	153

ARTICLES

THE FOURTH DIMENSION ... D. M. PATEL	161
THE TEACHING OF GEOMETRICAL OPTICS ... H. J. TAYLOR	173
TECHNIQUE OF THE FAR INFRA-RED INVESTIGATIONS N. R. TAWDE, Y. G. NAIK, & D. D. DESAI	181
THE PRESENT POSITION REGARDING THE THEORIES ABOUT THE NATURE OF ACTIVE NITROGEN C. R. DHODAPKAR	190
A NOTE ON INTERPOLATION FORMULAS ... D. K. SEN	200
A CRITICAL SURVEY OF THE VALENCY-DEFLEXION HYPOTHESIS ... R D DESAI	206

SUMMARIES AND ABSTRACTS OF THESES FOR M. Sc. DEGREES 215NOTES & NEWS ... 231REVIEWS ... 236ACKNOWLEDGMENTS ... 244EXCHANGES ... 248

“MOVING AXES FORMULÆ IN THE n -DIMENSIONAL SPACE.”

By

G. S. MAHAJANI. M. A., Ph. D. (Cantab.)

Fergusson College, Poona.

[The present article is suggested by an attempt to generalize the result in the following example :—“ A quadric surface whose equation relative to fixed axes is at any instant

$$ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = 1$$

is of invariable form, but is rotating about the origin with the angular velocity (p, q, r) . Prove that

$$\frac{da}{dt} = 2(gq - hr) \text{ etc; etc;}$$

$$\frac{df}{dt} = (b - c)p + gr - hq \text{ etc; etc;}$$

Deduce the Conditions that the surface should be of revolution.”

[Lamb's *Higher Mechanics*, Page 88.]

1° Let the (orthogonal) Cartesian Co-ordinates of a point P in the n -dimensional space be $(x_1, x_2, x_3, \dots, x_n)$ as referred to the *moving* frame of reference $O-x_1 x_2 x_3 \dots x_n$; and let the co-ordinates of a neighbouring point Q be

$$(x_1 + dx_1, x_2 + dx_2, \dots, x_n + dx_n).$$

We may regard the following as an axiomatic truth :—

Actual velocity of P = Velocity of P *relative* to the moving frame
+ the velocity which P would have in common with the frame, if rigidly connected with it.

The latter part consists of two parts,—that due to the translational motion of the frame, and the part due to its rotational motion.

With obvious notation we thus have—

$$\frac{D}{Dt} (x_1, x_2, x_3, \dots, x_n) = \frac{d}{dt} (x_1, x_2, x_3 \dots x_n)$$

$$+ (u_{01}, u_{02}, u_{03}, \dots, u_{0n})$$

$$+ \text{Rotational contribution.}$$

Note here that the above equation is a brief way of writing n separate equations, one for each component.

2° To find the Rotational Contribution: Let now O be fixed and let PQ be rigidly connected to the rotating frame O- $x_1, x_2 \dots x_n$. We make use of the principle that—

The relative velocity of two points P and Q of a rigid body is at right angles to the line PQ.

Symbolically this means

$$du_1 dx_1 + du_2 dx_2 + \dots + du_n dx_n = 0.$$

Let us adopt henceforth the usual 'summation convention' that whenever a linear suffix appears twice in a term that term is to be summed up for values of the suffix 1, 2, \dots n . The above then becomes

$$du_r dx_r = 0$$

$$\text{i. e. } \frac{\partial u_r}{\partial x_s} dx_s dx_r = 0$$

Since, however, the result is true for all values of dx_r, dx_s , we must have the several coefficients zero. That is:

$$\frac{\partial u_r}{\partial x_r} = 0, \quad \left. \begin{array}{l} r=1, 2, 3, \dots n \\ (n \text{ equations.}) \end{array} \right\} \text{I}$$

$$\text{and } \frac{\partial u_r}{\partial x_s} + \frac{\partial u_s}{\partial x_r} = 0, \quad \left. \begin{array}{l} (r, s=1, 2, 3, \dots n \\ r \neq s \\ (nC_2 \text{ equations}) \end{array} \right\} \text{II}$$

From I we conclude that u_r is independent of x_r .

Next, consider any one equation of the II type,

$$\frac{\partial u_r}{\partial x_s} + \frac{\partial u_s}{\partial x_r} = 0.$$

Differentiate this with respect to one of the variables *present*, say x_s , and we have

$$\frac{\partial}{\partial x_s} \left(\frac{\partial u_r}{\partial x_s} + \frac{\partial u_s}{\partial x_r} \right) = \frac{\partial^2 u_r}{\partial x_s^2} + \frac{\partial^2 u_s}{\partial x_r \partial x_s} = 0.$$

But $\frac{\partial u_s}{\partial x_s} = 0$ in virtue of I,

\therefore We simply have

$$\frac{\partial^2 u_r}{\partial x_s^2} = 0, \quad \left. \begin{array}{l} \text{every pair } r, s \\ r \neq s \end{array} \right\} \text{III}$$

Next, differentiate the same result

$$\frac{\partial u_r}{\partial x_s} + \frac{\partial u_s}{\partial x_r} = 0$$

with respect to any one of the *absent* variables, say x_i . And we get

$$\frac{\partial^2 u_r}{\partial x_s \partial x_i} + \frac{\partial^2 u_s}{\partial x_r \partial x_i} = 0, \quad r \neq s \neq i \quad \text{IV}$$

For any pair (r, s) IV represents $(n-2)$ equations; there are nC_2 such pairs. Hence the number of separate equations in IV is

$$(n-2) {}^nC_2.$$

Further, the number of different variables of the type $\frac{\partial^2 u_r}{\partial x_s \partial x_t}$ are in all

$$n. {}^{n-1}C_2 = (n-2). {}^nC_2$$

i.e. we have as many linear equations as we have the number of different variables. Each equation is simply a statement that the sum of any two of the variables is zero. The conclusion, therefore, is forced upon us that *each is zero*.

$$\text{i.e. } \frac{\partial^2 u_r}{\partial x_s \partial x_t} = 0 \quad r \neq s \neq t$$

Thus we conclude that there cannot be in the expression for μ_r , terms of higher than the first degree in x_s, x_t etc.

We may write therefore—

$$u_r = \omega_{sr} x_s \quad r \neq s$$

where ω_{sr} are constants depending upon the *rotation* of the frame.

In virtue of IV above we must have

$$\omega_{sr} + \omega_{rs} = 0.$$

3°. Taking into account the translational motion of O, the formula for the velocity component of a point *rigidly* connected with the frame becomes

$$u_r = u_{or} + \omega_{sr} x_s, \quad r \neq s.$$

If the point itself has a motion *relative* to the frame then the most general formula is given by

$$u_r \equiv \frac{Dx_r}{Dt} = \frac{dx_r}{dt} + u_{or} + \omega_{sr} x_s. \quad r \neq s.$$

$$\therefore \omega_{sr} + \omega_{rs} = 0$$

we have $\omega_{11} = \omega_{22} = \omega_{33} = \dots = 0$

Hence we may not have the restriction $r \neq s$ in

$$u_r = u_{or} + \omega_{sr} x_s.$$

The number of constants ω_{sr} ($r \neq s$) is nC_2 , and exactly equals the number of the co-ordinate planes of the frame $O-x_1 x_2 x_3 \dots x_n$. We define that—

ω_{sr} are the components of angular velocity, perpendicular to the co-ordinate places $O-x_s x_r$.

4°. As a particular case if the frame has only rotational movement then

$$u_r = \dot{x}_r + \omega_{ir} x_i.$$

and if the point is actually fixed, then its velocity *relative* to the frame is given by $0 = \dot{x}_r + \omega_{rs} x_s$

or $\dot{x}_r = \omega_{rs} x_s$.

5°. Application. To find the conditions that a quadric surface in the n -dimensional space should be one of revolution.

Let the equation to the quadric be

$$a_{\alpha\beta} x_\alpha x_\beta = 1. \quad \left\{ \alpha, \beta = 1, 2, \dots n \right.$$

Let ω_{rs} be the components of the angular velocity with which it is set rotating about its frame $O-x_1 x_2 \dots x_n$ which is fixed. Impose the opposite angular velocity ω_{rs} , so that the quadric is brought to rest, but the axes are now set rotating with ω_{rs} . Then the velocity of any point $(x_1, x_2, \dots x_n)$ on the quadric *relative* to the axes is given by the formula obtained in 4° above *viz*:

$$\dot{x}_\mu = \omega_{\mu s} x_s.$$

Differentiating the equation to the quadric

$$a_{\alpha\beta} x_\alpha x_\beta = 1$$

we get

$$a_{\alpha\beta} x_\alpha \dot{x}_\beta + a_{\alpha\beta} (\dot{x}_\alpha x_\beta + x_\alpha \dot{x}_\beta) = 0$$

and substituting for $\dot{x}_\alpha, \dot{x}_\beta$, we get

$$a_{\alpha\beta} x_\alpha x_\beta + a_{\alpha\beta} (\omega_{s\alpha} x_s x_\beta + \omega_{s\beta} x_s x_\alpha) = 0$$

Now in the term $a_{\alpha\beta} \omega_{s\alpha} x_s x_\beta$ each suffix occurs twice and is therefore a 'dummy' suffix as we have to take summation over all the values from 1, 2... n . Hence a dummy suffix may be replaced by any other dummy suffix. Thus writing γ for α and α for s the term becomes

$$a_{\gamma\beta} \omega_{\alpha\gamma} x_\alpha x_\beta.$$

Similarly, the term $a_{\alpha\beta} \omega_{s\beta} x_s x_\alpha$ may be written as

$$a_{\gamma\alpha} \omega_{\beta\gamma} x_\beta x_\alpha.$$

Thus we get

$$(a_{\alpha\beta} + a_{\gamma\beta} \omega_{\alpha\gamma} + a_{\gamma\alpha} \omega_{\beta\gamma}) x_\beta x_\alpha = 0$$

And since this result is true for all the points of the quadric, (which are infinite), it follows that the coefficient of each term = 0

$$i. e. \quad a_{\alpha\beta} + a_{\gamma\beta} \omega_{\alpha\gamma} + a_{\gamma\alpha} \omega_{\beta\gamma} = 0$$

Remembering that

$$a_{\alpha\beta} = a_{\beta\alpha}$$

$$\text{and } \omega_{rs} = -\omega_{sr}$$

We may write the above as

$$\dot{a}_{\alpha\beta} = a_{\alpha\gamma} \omega_{\gamma\beta} + a_{\gamma\beta} \omega_{\gamma\alpha} \quad \} V$$

$$\left(\text{These are } {}^nC_2 + n \equiv \frac{n(n+1)}{2} \text{ equations.} \right)$$

Now if the quadric $a_{\alpha\beta} x_\alpha x_\beta = 1$

be a surface of revolution we must be able to choose the angular velocity (ω_{sr}) in such a manner that the rotation is about the axis of rotation,—in which case the quadric would maintain an *invariable* orientation with respect to the frame $O-x_1 x_2 \dots x_n$.

i. e. for a suitable choice of (ω_{sr})

$$\dot{a}_{\alpha\beta} = 0$$

$$\text{i. e. } a_{\gamma\alpha} \omega_{\gamma\beta} + a_{\gamma\beta} \omega_{\gamma\alpha} = 0 \quad \} VI$$

(${}^nC_2 + n$) equations.

All the equations, however, are not independent. For, if we consider just those n equations in which α & β are equal, we have

$$\dot{a}_{11} = a_{\gamma_1} \omega_{\gamma_1} + a_{\gamma_1} \omega_{\gamma_1} = 2a_{\gamma_1} \omega_{\gamma_1} = 0$$

$$\dot{a}_{22} = 2 a_{\gamma_2} \omega_{\gamma_2} = 0$$

$$\dot{a}_{33} = 2 a_{\gamma_3} \omega_{\gamma_3} = 0$$

$$\dots \dots \dots$$

$$\dot{a}_{nn} = 2a_{\gamma_n} \omega_{\gamma_n} = 0$$

Adding these up and remembering that $\omega_{rs} + \omega_{sr} = 0$, we have

$$\dot{a}_{11} + \dot{a}_{22} + \dot{a}_{33} + \dots + \dot{a}_{nn} = 0, \text{ identically.}$$

\therefore The number of independent equations in VI is only

$$\text{i. e. } {}^nC_2 + n - 1.$$

now there are nC_2 components of the angular velocity of the type (ω_{sr}). Eliminating these from the ${}^nC_2 + n - 1$ equations in VI, we shall get, *in general*, ($n - 1$) independent conditions in order that the quadric

$$a_{\alpha\beta} x_\alpha x_\beta = 1$$

be a surface of revolution.

6°. Particular case : Lamb's example in three dimensions.

We have

$$d_{\alpha\beta} = a_{\gamma\alpha} \omega_{\gamma\beta} + a_{\gamma\beta} \omega_{\gamma\alpha} \left\{ \begin{array}{l} a_{\mu\nu} = a_{\nu\mu} \\ \omega_{\mu\nu} + \omega_{\nu\mu} = 0 \end{array} \right.$$

$$(\alpha, \beta = 1, 2, 3).$$

Writing the equations separately we get

$$d_{11} = 2 (a_{12} \omega_{21} + a_{13} \omega_{31}), \text{ etc; etc;}$$

and $d_{23} = (a_{21} \omega_{13} + a_{22} \omega_{23}) + (a_{31} \omega_{12} + a_{33} \omega_{32}), \text{ etc;}$

Now writing as usual

$$a_{\alpha\beta} x_{\alpha} x_{\beta} \equiv ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = 1$$

We have

$$a_{11} = a, a_{22} = b, a_{33} = c$$

$$a_{23} = a_{32} = f, a_{31} = a_{13} = g, a_{12} = a_{21} = h.$$

Further, in conformity with the usual notation for the angular velocity we write

$$\omega_{23} = -\omega_{32} = \omega_1$$

$$\omega_{31} = -\omega_{13} = \omega_2$$

$$\omega_{12} = -\omega_{21} = \omega_3$$

And we obtain exactly the results given by Lamb viz :

$$\dot{a} = 2 (g\omega_2 - h\omega_3) \text{ etc; etc;}$$

$$\dot{f} = (b-c) \omega_1 + (g\omega_3 - h\omega_2) \text{ etc; etc.}$$

Proceeding to obtain the conditions for the quadric to be of revolution, we have simply to write

$$\dot{a} = \dot{b} = \dot{c} = \dot{f} = \dot{g} = \dot{h} = 0.$$

It is easily verified that

$$\dot{a} + \dot{b} + \dot{c} = 0 \text{ identically.}$$

i. e. $(a + b + c)$ is an invariant for the change of axes.

Eliminating $\omega_1, \omega_2, \omega_3$, from the five independent equations we get two independent conditions thus :—

$$\left. \begin{array}{l} g\omega_2 - h\omega_3 = 0 \\ h\omega_3 - f\omega_1 = 0 \\ f\omega_1 - g\omega_2 = 0 \end{array} \right\}$$

$$\therefore \frac{w_1}{f^{-1}} = \frac{w_2}{g^{-1}} = \frac{w_3}{h^{-1}}$$

which shows that the axis of revolution has its direction cosines proportional to $\left(\frac{1}{f}, \frac{1}{g}, \frac{1}{h}\right)$.

Next from $\dot{f} = 0$ we have

$$(b - c) \omega_1 + \begin{vmatrix} g & h \\ \omega_2 & \omega_3 \end{vmatrix} = 0$$

$$\text{i.e. } \frac{b - c}{f} + \begin{vmatrix} \frac{g}{f} & \frac{h}{f} \\ \frac{1}{g} & \frac{1}{h} \end{vmatrix} = 0$$

$$\begin{aligned} \text{i.e. } b - \frac{hf}{g} &= c - \frac{fg}{h} \\ &= a - \frac{gh}{c}, \text{ by symmetry} \end{aligned}$$

7°. Application to two dimensions.

$$a_{\alpha\beta} x_{\alpha} x_{\beta} \equiv ax^2 + 2hxy + by^2 = 1,$$

$$a_{11} = a, a_{12} = a_{21} = h, a_{22} = b$$

$$\omega_{12} = \omega_{21} = \omega_3 = \omega \text{ say}$$

The equations

$$\dot{a}_{\alpha\beta} = a_{\gamma\alpha} \omega_{\gamma\beta} + a_{\gamma\beta} \omega_{\gamma\alpha}$$

lead to

$$\dot{a} = \dot{a}_{11} = a_{21} \omega_{21} + a_{21} \omega_{21} = -2h\omega$$

$$\dot{b} = \dot{a}_{22} = a_{12} \omega_{12} + a_{12} \omega_{12} = 2h\omega$$

and

$$\dot{h} = \dot{a}_{12} = a_{11} \omega_{12} + a_{22} \omega_{21} = (a - b)\omega$$

Thus

$$\dot{a} = \dot{b} = \dot{h} = 0$$

yield

$$-2h\omega = 0$$

$$+2h\omega = 0$$

and

$$(a - b)\omega = 0.$$

Notice that it becomes *unnecessary* to eliminate ω , and *therefore* we get *two* conditions, and *not one* condition (as we might have been led to anticipate by the general formula viz. $n-1$ conditions).

Thus the quadric in two dimensions becomes one of revolution *i.e.* the ellipse becomes a circle if $a - b = 0$ and $h = 0$.

Notice incidentally that from

$$\dot{a} = -2h\omega$$

$$\dot{b} = 2h\omega$$

$$\dot{h} = (a - b)\omega$$

we also deduce that $(a + b)$ and $(ab - h^2)$ are invariant expressions for a change of rectangular axes.

8°. Summary of results:—

(1). The motion of the rigid frame of reference $0 - x_1 x_2 \dots x_n$ in the n -dimensional space (and hence of any rigid body of

n dimensions) is specified by two entities u and ω ; where u is a vector of translational motion having n components

$$u_r, r = 1, 2, 3 \dots n;$$

and ω stands for the angular velocity which is of the nature of an anti-symmetrical tensor having nC_2 components

$$\omega_{sr}, r, s = 1, 2, 3 \dots n$$

ω_{sr} represents the component perpendicular to the co-ordinate plane $0-x_s x_r$. It just happens that in the space of three dimensions the angular velocity has also exactly *three* components. In two dimensional motion the angular velocity has only one component.

(2). The formula for the velocity of any moving point $(x_1, x_2, \dots x_n)$ as referred to the moving frame is

$$u_r = \dot{x}_r + u_{or} + \omega_{sr} x_s, \quad r = 1, 2, \dots n.$$

(3). The conditions for the quadric

$$a_{\alpha\beta} x_\alpha x_\beta = 1$$

to be surface of revolution, are $n-1$ in number, and they are to be obtained by eliminating the nC_2 components ω_{sr} from the equations

$$\dot{a}_{\alpha\beta} = a_{\gamma\alpha} \omega_{\gamma\beta} + a_{\gamma\beta} \omega_{\gamma\alpha}.$$

These are ${}^nC_2 + n$ in number, but are only ${}^nC_2 + n-1$ independent relations in virtue of the identical result that

$$\dot{a}_{11} + \dot{a}_{22} + \dot{a}_{33} + \dots + \dot{a}_{nn} = 0.$$

(4) The number of conditions in two dimensions, however, is *two* (and not one) since it is found unnecessary to eliminate ω .

(5) Rotation in the n -dimensional space, to repeat the statement for emphasis, is specified by the angular velocity which is an anti-symmetrical tensor having nC_2 components (ω_{sr}) each perpendicular to the corresponding co-ordinate plane $0-x_s x_r$.

A CHAIN OF THEOREMS RELATING TO COLLINEAR AND CONCYCLIC POINTS.

By

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1. It is well-known that the feet of the perpendiculars drawn on the sides of a triangle from any point O on the circumcircle are collinear. Given four points on the circle, they can be taken in sets of three in four ways. We will show that the feet of the perpendiculars from any point O on the circle to the four pedal lines of O with respect to the four triangles are in a line called the pedal line of O with respect to the four points. We may state a similar theorem again for five points on the circle and so on. The general theorem for any number of points on the circle was proved and developed by the writer in the *Journal of the Indian Mathematical Society* (Vol. XIX. 1932. pp. 267-272). The method adopted was by reciprocating a particular case of another chain of theorems (Coolidge: *A Treatise on the circle and the Sphere*. 1916. p. 92. Th. 164.) concerning any number of lines in a plane, the particular case being when the lines are all tangents to a parabola. The object of this paper is to connect these two chains of theorems by inversion. Incidentally, a third chain of theorems is obtained, which seems to be new and worthy of notice.

2. These new theorems may be stated as follows. Let O be a fixed point and l a fixed straight line not passing through O . Let A_1, A_2, A_3 be any three points on l . Then, the centres of the three circles $OA_1A_2, OA_2A_3, OA_3A_1$ lie on a circle passing through O . Let us denote this circle by $(A_1A_2A_3)$. Again, let there be four points A_1, A_2, A_3, A_4 on l . The centres of the four circles $(A_2A_3A_4), (A_3A_4A_1), (A_4A_1A_2), (A_1A_2A_3)$ lie on a circle passing through O , this circle being denoted by $(A_1A_2A_3A_4)$. In general, given n points A_1, A_2, \dots, A_n on l , the centres of the n circles, each associated with a set of $n-1$ of the n points, lie on circle passing through O .

3. To prove this, we require the theorem concerning any number of tangents to a parabola, referred to above. Given any four coplanar lines, the circumcircles of the four triangles formed by them pass through the Miquel point, which is the focus of the unique parabola touching the four lines. The additional fact in which we

are interested is that the four circumcentres are concyclic with the Miquel point. The circle so defined may be called the centre-circle of the four lines. Now, if five lines are given, they can be taken in sets of four in five ways and the centres of the five centre-circles are again concyclic, giving the centre-circle of five lines, and so on. The extension to any number of lines in the plane being assumed (Coolidge : loc. cit.), we remark that, if all the lines be not of general position, but are tangents to a parabola, the centre-circles obtained at any stage all pass through the focus. Now, let us describe a parabola touching the given straight line l and having O for the focus. The parabola may be fixed by one more tangent which may be chosen to be an arbitrary line l_1 through A_1 . Let l_1 cut the circle OA_1A_2 in B and BA_2 cut the circle OA_2A_3 in C . Then BA_2 , CA_3 are tangents to the parabola and O is the Miquel point of the lines l , l_1 , BA_2 , CA_3 . Thus, the centre-circle of these four lines contains the circumcentres of the triangles OA_1A_2 , OA_2A_3 , OA_3A_1 and passes through O . Again, to these four lines add a fifth, namely, the tangent (other than l) from A_4 to the parabola. The circles $(A_2A_3A_4)$, $(A_3A_4A_1)$, etc., become the centre circles of sets of four from the five lines and hence their centres are concyclic with O . We may, thus, continue to take more points on the line l and by considering the tangents from them to the parabola, prove the theorem of art. 2.

4. A simple independent proof can also be given by the use of polar co-ordinates, if we observe that at any stage, instead of taking the centres of the system of circles, we may take the points on these circles diametrically opposite to O . Obviously, these may be proved to be concyclic, in turn. Let O be the origin and the line from O perpendicular to l be the initial line, so that the equation of l may be written $r \cos \theta = p$. Let the points A_i be given by $(p \sec \alpha_i, \alpha_i)$. Then, the equation of the circle OA_1A_2 is

$$r = p \sec \alpha_1 \sec \alpha_2 \cos (\theta - \alpha_1 - \alpha_2)$$

which shows that the point on this circle diametrically opposite to O has co-ordinates

$$(p \sec \alpha_1 \sec \alpha_2, \alpha_1 + \alpha_2).$$

Similarly writing down the co-ordinates of the points diametrically opposite to O on the circles OA_2A_3 , OA_3A_1 , we easily verify that these points lie again on the circle passing through O and whose equation is

$$r = p \sec \alpha_1 \sec \alpha_2 \sec \alpha_3 \cos (\theta - \alpha_1 - \alpha_2 - \alpha_3)$$

The proof of the general case is now obvious and the theorem is established.

5. Now, invert with O as centre. The line l and the points A_1, A_2, A_3 , are transformed into a circle L through O and points

a_1, a_2, a_3 , on L . The circles OA_1A_2 , OA_2A_3 , OA_3A_1 go over into the sides of the triangle $a_1 a_2 a_3$. A diameter of a circle being orthogonal to it, the point on the circle $OA_1 A_2$ diametrically opposite to O is inverted into the foot of the perpendicular from O on the side $A_1 A_2$. Thus, the theorem proved above shows that the feet of the perpendiculars from O on the sides of $a_1 a_2 a_3$ are collinear. Again, the point diametrically opposite to O on the circle through the points diametrically opposite to O of OA_1A_2 , OA_2A_3 , OA_3A_1 , inverts into the foot of the perpendicular from O on the pedal line of O with respect to $a_1 a_2 a_3$. Thus, again, from the theorem of art 4, it follows by inversion, that given four points $a_1 a_2 a_3 a_4$ on a circle through O , the feet of the perpendiculars from O on the four pedal lines of O with respect to $a_2 a_3 a_4$, $a_3 a_4 a_1$, etc., are collinear. The general theorem for n points on a circle is clearly seen to be true by successive inversion.

6. We may also obtain other results by inverting the theorem of pedal lines, if we choose the centre of inversion to be an arbitrary point on the circle. The following is easily proved. Let A, B, C, D be any four collinear points and O any other point. Then, the circles through D, O orthogonal to the circles OAB, OBC, OCA cut them respectively in three points lying on a circle passing through O . Let us denote this circle by $D (ABC)$. The theorem that the pedal lines of each of four concyclic points with respect to the remaining three pass through a fixed point, gives on inversion the theorem that the circles $D (ABC), A (BCD), B (CAD), C (DAB)$ are coaxial. The result of taking any other point of the plane as the centre of inversion is not so elegant or interesting.

RESISTANCE OF A GENERAL ELLIPSOID MOVING IN A VISCOUS FLUID.

By

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In a paper published in the *Proceedings of the Benares Mathematical Society*, Vol. II, 1920, I had tackled the problem of uniform motion of an ellipsoid of revolution through a viscous fluid and had, by considering the *complete* equations of motion, derived the conditions of fluid motion and the expression for the resistance experienced by the spheroid. My object in the present paper has merely been to deduce an expression for the resistance to uniform motion of a general ellipsoid (having small ellipticities). For this purpose I have taken the results of my previous paper as guides and employed the method of polynomials in obtaining the solutions to the complete equations of motion. I intend to obtain a more satisfactory form of the solutions in a subsequent work and here I have only to express my thankfulness to the late Dr. Ganesh Prasad who had directed my attention to these problems.

Let the equation of the ellipsoid be

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1 \quad , \quad . \quad . \quad . \quad . \quad (1)$$

where $a > b > c$, and let $\epsilon_1, \epsilon_2, \epsilon_3$ denote halves of the squares of the eccentricities of its three principal sections. If

$$\rho^2 = x^2 + y^2 + z^2, \quad . \quad . \quad . \quad . \quad (2)$$

then this equation can be put as

$$\rho = a \left(1 - \frac{\epsilon_1}{a^2} y^2 - \frac{\epsilon_2}{a^2} z^2 \right) \quad . \quad . \quad . \quad . \quad (2)$$

approximately, upto terms in first degree in ϵ_1 and ϵ_2 . We shall consider the case when ϵ_1 and ϵ_2 as well as ka are small quantities, k standing for (velocity)/2 ν for the solid.

To start with, let the ellipsoid move parallel to the x -axis with a uniform velocity U . Obviously the expressions for the component-velocities u, v, w , and pressure p of the fluid motion for an ellipsoid differ from those of a sphere in possessing some additional terms involving the ϵ 's. Following the method of polynomials we assume that these additional terms for u, v, w are of the form

$$\Sigma a_n \rho^{-n}, \quad \Sigma b_n \rho^{-n}, \quad \Sigma c_n \rho^{-n} \quad . \quad . \quad . \quad . \quad (3)$$

respectively, where the a 's, b 's and c 's are functions of x , y and z , and each summation extends over a finite number of terms only.

Now, the corresponding terms as obtained by me for the motion of an ellipsoid of revolution (having the longest axis $2a$ for its axis of revolution) when simplified of exponential factors, are (*loc. cit.*)

$$U \propto \left[\left(-\frac{3}{5} \frac{a}{\rho^3} - \frac{9}{20} \frac{a^3}{\rho^5} - \frac{9}{20} \frac{a^5}{\rho^7} \right) + x^2 \left(-\frac{3}{5} \frac{a}{\rho^3} - \frac{9a^3}{10\rho^5} + \frac{9}{2} \frac{a^5}{\rho^7} \right) + x^4 \left(\frac{15}{4} \frac{a^3}{\rho^7} - \frac{21}{4} \frac{a^5}{\rho^9} \right) \right], \quad (4)$$

$$U \propto x y \left[\left(-\frac{3}{5} \frac{a}{\rho^3} - \frac{3}{20} \frac{a^3}{\rho^5} + \frac{9}{4} \frac{a^5}{\rho^7} \right) + x^2 \left(\frac{15}{4} \frac{a^3}{\rho^7} - \frac{21}{4} \frac{a^5}{\rho^9} \right) \right]. \quad (5)$$

$$U \propto x z \left[\left(-\frac{3}{5} \frac{a}{\rho^3} - \frac{3}{20} \frac{a^3}{\rho^5} + \frac{9}{4} \frac{a^5}{\rho^7} \right) + x^2 \left(\frac{15}{4} \frac{a^3}{\rho^7} - \frac{21}{4} \frac{a^5}{\rho^9} \right) \right]. \quad (6)$$

respectively. And since $x^2 = \rho^2 - y^2 - z^2$, these lead us to assume that for the general ellipsoid

$$\begin{aligned} \Sigma a_n \rho^{-n} = & A_1 \rho^{-1} + (A_3 + A_{31} y^2 + A_{32} z^2) \rho^{-3} + (A_5 + A_{51} y^2 + A_{52} z^2) \rho^{-5} \\ & + (A_{71} y^2 + A_{72} z^2 + A_{73} y^4 + A_{74} z^4 + A_{75} y^2 z^2) \rho^{-7} \\ & + (A_{91} y^4 + A_{92} z^4 + A_{93} y^2 z^2) \rho^{-9}, \quad (7) \end{aligned}$$

$$\begin{aligned} \Sigma b_n \rho^{-n} = & xy \left[B_3 \rho^{-3} + B_5 \rho^{-5} + (B_7 + B_{71} y^2 + B_{72} z^2) \rho^{-7} \right. \\ & \left. + (B_{91} y^2 + B_{92} z^2) \rho^{-9} \right], \quad (8) \end{aligned}$$

$$\begin{aligned} \Sigma c_n \rho^{-n} = & xz \left[C_3 \rho^{-3} + C_5 \rho^{-5} + (C_7 + C_{71} y^2 + C_{72} z^2) \rho^{-7} \right. \\ & \left. + (C_{91} y^2 + C_{92} z^2) \rho^{-9} \right]. \quad (9) \end{aligned}$$

These assumed values of u , v , w have to satisfy the following conditions

- $$\left. \begin{array}{l} \text{(i) the equations of fluid motion;} \\ \text{(ii) } u = U, v = 0, w = 0 \text{ on the ellipsoid; and} \\ \text{(iii) } u = 0, v = 0, w = 0 \text{ at infinity.} \end{array} \right\} \quad (10)$$

It is easy to see from the form of the values assumed that the third condition is fulfilled. It remains therefore to determine such values of the constants as shall be in accord with the first two conditions. If p be eliminated from the hydrodynamical equations of motion by cross-differentiation, we get

$$\begin{aligned} \nabla^2 \left(\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x} \right) = & \frac{1}{\nu} \left[\frac{\partial}{\partial y} \left\{ (u-U) \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right\} \right. \\ & \left. - \frac{\partial}{\partial x} \left\{ (u-U) \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} \right\} \right], \quad (11) \end{aligned}$$

$$\begin{aligned} \nabla^2 \left(\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x} \right) = & \frac{1}{\nu} \left[\frac{\partial}{\partial z} \left\{ (u-U) \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right\} \right. \\ & \left. - \frac{\partial}{\partial x} \left\{ (u-U) \frac{\partial w}{\partial x} + v \frac{\partial w}{\partial y} + w \frac{\partial w}{\partial z} \right\} \right]. \quad (12) \end{aligned}$$

$$\text{and} \quad \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \quad . \quad . \quad . \quad . \quad . \quad (13)$$

We substitute the assumed values in (11), (12), and (13), replace x^2 wherever it occurs by $(\rho^2 - y^2 - z^2)$, simplify and equate the coefficients of similar terms from both sides. As the result thereof we obtain *twenty* independent equations involving the *twenty-nine* unknown constants introduced above. In all these calculations terms in second and higher degrees in k and the ϵ 's have been neglected. For the remaining *nine* equations we turn to the second condition of (10); that is we put $u = U$, $v = 0$, $w = 0$ and $\rho =$ the right-hand side of (2), and equate the coefficients of similar terms as before. Thus we arrive at just the sufficient number of equations which lead to the following values of the constants:

$$\begin{aligned} A_1 &= -\frac{3}{5} Ua (\epsilon_1 + \epsilon_2); \quad A_3 = \frac{6}{5} Ua^3 (\epsilon_1 + \epsilon_2); \\ A_{31} &= A_{32} = \frac{3}{20} Ua (\epsilon_1 + \epsilon_2); \quad A_5 = -\frac{3}{5} Ua^5 (\epsilon_1 + \epsilon_2); \\ A_{51} &= -\frac{3}{20} Ua^3 (37 \epsilon_1 + 7 \epsilon_2); \quad A_{52} = -\frac{3}{20} Ua^3 (7 \epsilon_1 + 37 \epsilon_2); \\ A_{71} &= \frac{3}{4} Ua^5 (7 \epsilon_1 + \epsilon_2); \quad A_{72} = \frac{3}{4} Ua^5 (\epsilon_1 + 7 \epsilon_2); \\ A_{73} &= \frac{15}{4} Ua^3 \epsilon_1; \quad A_{74} = \frac{15}{4} Ua^3 \epsilon_2; \quad A_{75} = A_{73} + A_{74}; \\ A_{91} &= -\frac{21}{4} Ua^5 \epsilon_1; \quad A_{92} = -\frac{21}{4} Ua^5 \epsilon_2; \quad A_{93} = A_{91} + A_{92} \quad . \quad . \quad . \quad (14) \\ B_3 &= C_3 = -\frac{3}{10} Ua (\epsilon_1 + \epsilon_2); \\ B_5 &= \frac{3}{20} Ua^3 (17 \epsilon_1 + 7 \epsilon_2); \quad C_5 = \frac{3}{20} Ua^3 (7 \epsilon_1 + 17 \epsilon_2); \\ B_7 &= -\frac{3}{4} Ua^5 (3 \epsilon_1 + \epsilon_2); \quad C_7 = -\frac{3}{4} Ua^5 (\epsilon_1 + 3 \epsilon_2); \\ B_{71} &= C_{71} = -\frac{15}{4} Ua^3 \epsilon_1; \quad B_{72} = C_{72} = -\frac{15}{4} Ua^3 \epsilon_2; \\ B_{91} &= C_{91} = \frac{21}{4} Ua^5 \epsilon_1; \quad B_{92} = C_{92} = \frac{21}{4} Ua^5 \epsilon_2 \quad . \quad . \quad . \quad (15) \end{aligned}$$

These conditions determine the state of fluid motion due to the uniform translation of the general ellipsoid along the x -axis. Let us represent the results by

$$u = U f_1(x, y, z, a, \epsilon_1, \epsilon_2) + U \phi_1(x, y, z, a), \quad . \quad . \quad . \quad (16)$$

$$v = U f_2(x, y, z, a, \epsilon_1, \epsilon_2) + U \phi_2(x, y, z, a), \quad . \quad . \quad . \quad (17)$$

$$w = U f_3(x, y, z, a, \epsilon_1, \epsilon_2) + U \phi_3(x, y, z, a), \quad . \quad . \quad . \quad (18)$$

where the ϕ 's denote the results for the sphere and the f 's the additional parts for the ellipsoid. Using these values of u, v, w , we find

that the resistance experienced by the ellipsoid is parallel to the x -axis and is given by

$$F_x = -6 \pi \mu U a \left(1 + \frac{3}{4} ka - \frac{2}{5} \varepsilon_1 - \frac{2}{5} \varepsilon_2\right). \quad (19)$$

This result agrees, upto this degree of approximation, with that obtained by C. W. Oseen [Cf. equation (7), *Archiv der Mathematik und Physik*, Bd. 24, 1915, pp. 108–114], although Prof. Oseen had started from *incomplete* equations of motion. This was expected because his equations could give results only upto the first degree in k . Further, if the term in ka be dropped, (19) would lead to Oberbeck's result upto this approximation [*Crelle's Journal*, t. LXXXI, 1876].

Proceeding in the same manner as before we can get, when the ellipsoid is moving parallel to the y -axis with uniform velocity V ,

$$u = V f_3(y, z, x, b, \varepsilon_3, -\varepsilon_1) + V \phi_3(y, z, x, b), \quad (20)$$

$$v = V f_1(y, z, x, b, \varepsilon_3, -\varepsilon_1) + V \phi_1(y, z, x, b), \quad (21)$$

$$w = V f_2(y, z, x, b, \varepsilon_3, -\varepsilon_1) + V \phi_2(y, z, x, b), \quad (22)$$

leading to

$$F_y = -6 \pi \mu V b \left(1 + \frac{3}{4} kb + \frac{2}{5} \varepsilon_1 - \frac{2}{5} \varepsilon_3\right); \quad (23)$$

and similarly when the motion is parallel to the z -axis with uniform speed W , we have

$$u = W f_2(z, x, y, c, -\varepsilon_2, -\varepsilon_3) + W \phi_2(z, x, y, c), \quad (24)$$

$$v = W f_3(z, x, y, c, -\varepsilon_2, -\varepsilon_3) + W \phi_3(z, x, y, c), \quad (25)$$

$$w = W f_1(z, x, y, c, -\varepsilon_2, -\varepsilon_3) + W \phi_1(z, x, y, c), \quad (26)$$

and

$$F_z = -6 \pi \mu W c \left(1 + \frac{3}{4} kc + \frac{2}{5} \varepsilon_2 + \frac{2}{5} \varepsilon_3\right). \quad (27)$$

In general, when the solid is moving in any direction with a uniform velocity whose components parallel to the x -, y - and z -axes are U , V , W respectively, the fluid motion can be obtained, upto this approximation, by superposing (that is, by adding the corresponding expressions for) the values of u , v , w in the three cases given above. And the formulas (19), (23) and (27) will denote the components of the resistance of the ellipsoid.

By repeating the process indicated above and retaining the terms of the second (or higher) degrees in the ε 's or in ka , we can obtain results upto any desired degree of approximation, only that we have to add a number of terms at every step and thus make the

calculations more elaborate. Symbolically, we can summarise the process thus:

Let

$$\left. \begin{aligned} u &= u_0 + u_1 + u_2 + \dots \\ v &= v_0 + v_1 + v_2 + \dots \\ w &= w_0 + w_1 + w_2 + \dots \\ p &= p_0 + p_1 + p_2 + \dots \end{aligned} \right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

where u_0, v_0, w_0, p_0 stand for the corresponding values for the sphere of radius a ; u_1, v_1, w_1, p_1 are additional terms of the first degree for the ellipsoid, and u_2, v_2, w_2, p_2 those of the second degree, etc., in the ϵ 's and in k (if necessary). The number of terms on the right-hand side is always finite since they are being added one by one. The conditions to be satisfied are:

- (i) the equations of motion;
 - (ii) $u = U, v = V, w = W$, on the ellipsoid;
 - (iii) $u = 0, v = 0, w = 0$, at infinity.
- $$\left. \begin{aligned} & \\ & \\ & \end{aligned} \right\} \quad . \quad . \quad . \quad . \quad (10A)$$

As u_0, v_0, w_0 already satisfy the above conditions, and as the additional terms are added step by step, we see that the conditions (ii) and (iii) are to be replaced by

$$\left. \begin{aligned} (ii) \quad u_n &= 0, \quad v_n = 0, \quad w_n = 0 \text{ on the ellipsoid, } n=1, 2, 3 \dots \\ (iii) \quad u_n &= 0, \quad v_n = 0, \quad w_n = 0 \text{ at infinity, } n=1, 2, 3 \dots \end{aligned} \right\} \quad (10B)$$

The equation of continuity leads to

$$\frac{\partial}{\partial x} (u_n) + \frac{\partial}{\partial y} (v_n) + \frac{\partial}{\partial z} (w_n) = 0; \quad (29)$$

and the other equations of motion can be suitably modified for simplification at every stage. The equation to the ellipsoid is to be put as

$$\rho = a + F_1 + F_2 + \dots \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

THE RECESSION OF THE SPIRAL NEBULAE

BY

K. V. SASTRY, M. Sc. (Benares)

(*Communicated by Prof. V. V. Narlikar*)

The spiral nebulae recede according to the law,

$$\frac{\dot{x}}{x} = \frac{\dot{y}}{y} = \frac{\dot{z}}{z} = \frac{1}{t} \dots \dots \dots (1)$$

Prof. Narlikar* has already shown that this law is the only set of relations between the position, time and velocity of a nebula which remains invariant for the Lorentz transformation. We examine in this note the nature of transformations for which (1) remains invariant. Let us consider the transformation,

$$x' = f_1(x, y, z, t), \quad y' = f_2(x, y, z, t), \quad z' = f_3(x, y, z, t) \quad \text{and} \quad t' = f_4(x, y, z, t). \dots \dots \dots (2)$$

Let us suppose that this transformation yields

$x'/x' = y'/y' = z'/z' = 1/t'$ from (1). Then

$$\begin{aligned} \frac{1}{f_4} &= \frac{\frac{\partial f_1}{\partial x} x + \frac{\partial f_1}{\partial y} y + \frac{\partial f_1}{\partial z} z + \frac{\partial f_1}{\partial t}}{\frac{\partial f_4}{\partial x} x + \frac{\partial f_4}{\partial y} y + \frac{\partial f_4}{\partial z} z + \frac{\partial f_4}{\partial t}} \\ &= \frac{x \frac{\partial f_1}{\partial x} + y \frac{\partial f_1}{\partial y} + z \frac{\partial f_1}{\partial z} + t \frac{\partial f_1}{\partial t}}{x \frac{\partial f_4}{\partial x} + y \frac{\partial f_4}{\partial y} + z \frac{\partial f_4}{\partial z} + t \frac{\partial f_4}{\partial t}} \dots \dots \dots (3) \end{aligned}$$

It is clear from (3) that if f_1, f_2, f_3, f_4 are homogeneous polynomials in (x, y, z, t) then the degree of each polynomial must be the same, say, n .

Further if x, y, z, t , are expressed in terms of x', y', z', t' then by the extended principle of relativity, x, y, z, t , each must be a polynomial of degree n in x', y', z', t' , which will be possible only if $n=1$. Hence any linear transformation between x, y, z, t and x', y', z', t' , not necessarily of the Lorentz type, leaves the law of recession invariant. This can also be easily verified.

* *Nature*, Jan. 26, 1935, p. 149.

The preceding argument can be generalized to include the solutions where f_1, f_2, f_3, f_4 are not necessarily polynomials but homogeneous functions to which Euler's theorem of differentiation becomes applicable. It is really the postulated invariance of the form of the transformation that gives us the linearity.

If no assumption is made about the forms of f_1 and f_4 one obtains from (3) that $\log (f_1 / f_4)$ must satisfy the differential equation

$$x \frac{\partial \phi}{\partial x} + y \frac{\partial \phi}{\partial y} + z \frac{\partial \phi}{\partial z} + t \frac{\partial \phi}{\partial t} = 0$$

the possibility of ϕ being a homogeneous function of x, y, z, t has already been considered. Suppose now that ϕ is a function of r and t so that

$$r \frac{\partial \phi}{\partial r} + t \frac{\partial \phi}{\partial t} = 0$$

*giving $f_1 / f_4 = e^{\psi(r/t)}$, where ψ is any function.

Thus the invariance holds good also for transformations of the form

$$x' = t' e^{\psi_1(r/t)}, \quad y' = t' e^{\psi_2(r/t)}, \quad z' = t' e^{\psi_3(r/t)}.$$

A NOTE ON THE UNDISTURBED PLANETARY MOTION

BY

D. R. SHARMA, M.Sc. (Benares).

(Communicated by Prof. V. V. Narlikar)

We derive in this paper certain properties of the undisturbed planetary motion about the sun. The properties are perhaps trivial but probably of sufficient interest to be placed on record.

Taking a set of rectangular axes in the plane of the motion let us denote by (x_1, o) the position of the sun at any instant t , the position of the planet by (x, y) and its velocity relative to the sun by (u, v) . If (x_0, o) is the centre of the ellipse at time t we have in the usual notation,

$$x_1 - x_0 = ae, \quad (1)$$

$$x - x_0 = a \cos \Theta, \quad (2)$$

$$y = a(1 - e^2)^{\frac{1}{2}} \sin \Theta, \quad (3)$$

$$u = -(\mu/a)^{\frac{1}{2}} \sin \Theta / (1 - e \cos \Theta), \quad (4)$$

$$v = (\mu/a)^{\frac{1}{2}} (1 - e^2)^{\frac{1}{2}} \cos \Theta / (1 - e \cos \Theta), \quad (5)$$

Θ being eccentric anomaly, Choosing any origin and substituting $u = \lambda X$ and $v = \lambda Y$ where X and Y are rectangular co-ordinates we find on eliminating Θ from (4) and (5)

$$X^2 + (Y - K \tan \phi / \lambda)^2 = K^2 \sec^2 \phi / \lambda^2, \quad \dots (6)$$

where $\sin \phi = e$ and $K = \sqrt{\mu/a}$.

Eliminating Θ and e successively from (3), (4) and (5) we obtain

$$a = \frac{uy}{v} \frac{\left\{ (x_1 - x)^2 + y^2 \right\}^{\frac{1}{2}} \left\{ x_1 - x + \frac{uy}{v} \right\}}{\left\{ (x_1 - x + \frac{uy}{v})^2 - (x_1 - x)^2 - y^2 \right\}} \quad (7)$$

Similarly, from (1), (2) and (7),

$$e = \frac{(x_1 - x - vy/u)}{\left\{ y^2 + (x_1 - x)^2 \right\}^{\frac{1}{2}}} \quad (8)$$

$$\text{Also } \mu = \frac{uv}{y} (x_1 - x + uy/v) \left[y^2 + (x_1 - x)^2 \right]^{\frac{1}{2}} \dots (9)$$

From (7), (8) and (9) we can obtain expressions for the period T of the motion, the area of the ellipse and the constant of angular momentum. Thus we obtain the exact relations between the constants a, e, μ of the motion and the co-ordinates and the relative velocity at any instant of the motion.

A SIMPLIFICATION OF EINSTEIN'S EQUATIONS.

By

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and

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INTRODUCTION.

In the following we are concerned only with those solutions of the relativistic equations of gravitation which are associated with a line-element of the form

$$ds^2 = -\theta_1^2 dx_1^2 - \theta_2^2 dx_2^2 - \theta_3^2 dx_3^2 + \theta_4^2 dx_4^2 \dots \dots \dots \quad (1)$$

where $\theta = \theta(x_1, x_2, x_3, x_4)$. This form has been found out to be very useful in most of the relativistic discussions of problems of cosmogony and is, therefore, chosen here as the subject of discussion. It is obvious that some of the well-known solutions of Einstein's gravitational equations are particular cases of the form (i): Lemaître's and Schwarzschild's may be quoted as particular cases. To proceed with the discussion any assumption that is made about the energy tensor must be clearly set out. A perfectly general energy tensor would naturally mean a perfectly general distribution of matter the exploration of which would be beyond our mathematical reach. A vast number of discussions have already been made with certain restricted assumptions about the distribution of matter in the field. We assume here as in several cognate discussions, that there is no flux of matter outward or inward, and that only the four principal components of the energy tensor, $T_{\mu r}$, are therefore non-zero.

One* of us has already shown elsewhere that the relativity equations to be solved for the form (1) can be put in a strikingly neat form involving Laplacian operators of the first and the second kind. The ten components of the contracted Riemann-Christoffel Tensor $G_{\mu\nu}$ furnish us with the ten gravitational equations; only six of these are independent, in general, owing to the four well-known identities. It is possible that, under certain circumstances, the six equations which involve the six non-principal components of the tensor $G_{\mu\nu}$ are all independent. In our case these six equations are the simplest as we have assumed that only the principal components of $T_{\mu\nu}$ are

* "Relativity & Cosmogony", lectures given by V. V. Narlikar before the University of Bombay, Jan. 1933, Bombay University Journal, 1933.

non-zero. In this paper we, therefore, consider only these six equations and devise a method to tackle them. In case these six equations are all independent the remaining four may be said to define the components of the energy tensor, when this is not so one or more of the principal equations must be solved before the field can be explored. All considerations about the four principal equations have however, been postponed to the second paper.

The very form in which the six equations appear here enables us to split each of them into two for the sake of investigation. We deal here with these twelve equations, get some of their solutions, and indicate their geometrical significance. The new solutions thus derived are not all abstract: some of them, at least, should attract attention from the physical point of view as the most prominent solutions of Einstein's equations for gravitation are found to be particular members of this set of solutions.

THE EQUATIONS OF GRAVITATION

It is well-known that in the usual notation of relativity the tensor $G_{\mu\nu}$ is given by

$$G_{\mu\nu} = -\frac{\partial}{\partial x^\alpha} \{ \mu \gamma, \alpha \} + \{ \mu \alpha, \beta \} \{ \gamma \beta, \alpha \} + \frac{\partial^2}{\partial x^\mu \partial x^\nu} \log \sqrt{-g} - \{ \mu \gamma, \alpha \} \frac{\partial}{\partial x^\alpha} \log \sqrt{-g} \dots (2)$$

For the form (i) $x^1 = x_1, x^2 = x_2, x^3 = x_3, x^4 = x_4$ and $g_{11} = -\theta^2, g_{22} = -\theta^2, g_{33} = -\theta^2, g_{44} = \theta^2$, while $g_{\mu\gamma} = 0, \mu \neq \gamma$.

Substituting these in (2) we have

$$\begin{aligned} G_{11} = & -\frac{\partial}{\partial x_1} \{ 11, 1 \} - \frac{\partial}{\partial x_2} \{ 11, 2 \} - \frac{\partial}{\partial x_3} \{ 11, 3 \} - \frac{\partial}{\partial x_4} \{ 11, 4 \} + \{ 11, 1 \} \\ & \{ 11, 1 \} + \{ 11, 2 \} \{ 12, 1 \} + \{ 11, 3 \} \{ 13, 1 \} + \{ 11, 4 \} \{ 14, 1 \} + \{ 12, 1 \} \\ & \{ 11, 2 \} + \{ 12, 2 \} \{ 12, 2 \} + \{ 12, 3 \} \{ 13, 2 \} + \{ 12, 4 \} \{ 14, 2 \} + \{ 13, 1 \} \\ & \{ 11, 3 \} + \{ 13, 2 \} \{ 12, 3 \} + \{ 13, 3 \} \{ 13, 3 \} + \{ 13, 4 \} \{ 14, 3 \} + \{ 14, 1 \} \\ & \{ 11, 4 \} + \{ 14, 2 \} \{ 12, 4 \} + \{ 14, 3 \} \{ 13, 4 \} + \{ 14, 4 \} \{ 14, 4 \} + \frac{\partial^2}{\partial x_1^2} \\ & \log (\theta_1 \theta_2 \theta_3 \theta_4) - \left[\{ 11, 1 \} \frac{\partial}{\partial x_1} + \{ 11, 2 \} \frac{\partial}{\partial x_2} + \{ 11, 3 \} \frac{\partial}{\partial x_3} + \right. \\ & \left. \{ 11, 4 \} \frac{\partial}{\partial x_4} \right] \log (\theta_1 \theta_2 \theta_3 \theta_4) = \frac{1}{\theta_2} \frac{\partial^2}{\partial x_1^2} \theta_2 + \frac{1}{\theta_3} \frac{\partial^2}{\partial x_1^2} \theta_3 + \frac{1}{\theta_4} \frac{\partial^2}{\partial x_1^2} \theta_4 - \\ & \frac{1}{\theta_1 \theta_2} \frac{\partial \theta_1}{\partial x_1} \frac{\partial \theta_2}{\partial x_1} - \frac{1}{\theta_1 \theta_3} \frac{\partial \theta_1}{\partial x_1} \frac{\partial \theta_3}{\partial x_1} - \frac{1}{\theta_1 \theta_4} \frac{\partial \theta_1}{\partial x_1} \frac{\partial \theta_4}{\partial x_1} + \frac{\theta_1}{\theta_2 \theta_3 \theta_4} \left\{ \frac{\partial}{\partial x_2} \right. \\ & \left. \left(\frac{\theta_3 \theta_4}{\theta_2} \frac{\partial \theta_1}{\partial x_2} \right) + \frac{\partial}{\partial x_3} \left(\frac{\theta_2 \theta_4}{\theta_3} \frac{\partial \theta_1}{\partial x_3} \right) + \frac{\partial}{\partial x_4} \left(\frac{\theta_2 \theta_3}{\theta_4} \frac{\partial \theta_1}{\partial x_4} \right) \right\} \end{aligned}$$

$$\begin{aligned}
&= \theta_1^2 \left[\frac{1}{\theta_2} \frac{\partial^2 \theta_2}{\partial X_1^2} + \frac{1}{\theta_3} \frac{\partial^2 \theta_3}{\partial X_1^2} + \frac{1}{\theta_4} \frac{\partial^2 \theta_4}{\partial X_1^2} \right] + \theta_1 \nabla_1^2 \theta_1 \\
&= \theta_1^2 \left[\frac{\nabla_1^2 \theta_1}{\theta_1} + \frac{1}{\theta_2} \frac{\partial^2 \theta_2}{\partial X_1^2} + \frac{1}{\theta_3} \frac{\partial^2 \theta_3}{\partial X_1^2} + \frac{1}{\theta_4} \frac{\partial^2 \theta_4}{\partial X_1^2} \right] \dots \dots \dots (3)
\end{aligned}$$

where $\frac{\partial}{\partial X_1} = \frac{1}{\theta_1} \frac{\partial}{\partial x_1}$ and ∇_1^2 is the well-known Laplacian

operator for $\theta_2^2 \alpha x_2^2 + \theta_3^2 d x_3^2 + \theta_4^2 d x_4^2$. We can write similarly,

$$G_{22} = \theta_2^2 \left[\frac{\nabla_2^2 \theta_2}{\theta_2} + \frac{1}{\theta_1} \frac{\partial^2 \theta_1}{\partial X_2^2} + \frac{1}{\theta_3} \frac{\partial^2 \theta_3}{\partial X_2^2} + \frac{1}{\theta_4} \frac{\partial^2 \theta_4}{\partial X_2^2} \right]$$

$$G_{33} = \theta_3^2 \left[\frac{\nabla_3^2 \theta_3}{\theta_3} + \frac{1}{\theta_1} \frac{\partial^2 \theta_1}{\partial X_3^2} + \frac{1}{\theta_2} \frac{\partial^2 \theta_2}{\partial X_3^2} + \frac{1}{\theta_4} \frac{\partial^2 \theta_4}{\partial X_3^2} \right]$$

while G_{44} differs from G_{11} , G_{22} , G_{33} as is to be expected from (1) so that

$$G_{44} = \theta_4^2 \left[-\frac{\nabla_4^2 \theta_4}{\theta_4} + \frac{1}{\theta_1} \frac{\partial^2 \theta_1}{\partial X_4^2} + \frac{1}{\theta_2} \frac{\partial^2 \theta_2}{\partial X_4^2} + \frac{1}{\theta_3} \frac{\partial^2 \theta_3}{\partial X_4^2} \right]$$

Similarly calculations may be made for the non-principal components of $G_{\mu\gamma}$ for which μ is not equal to γ . Let us take for example G_{12} which reduces to

$$\begin{aligned}
&\frac{1}{\theta_3} \frac{\partial^2 \theta_3}{\partial x_1 \partial x_2} + \frac{1}{\theta_4} \frac{\partial^2 \theta_4}{\partial x_1 \partial x_2} - \frac{1}{\theta_1 \theta_3} \frac{\partial \theta_1}{\partial x_2} \frac{\partial \theta_3}{\partial x_1} - \frac{1}{\theta_1 \theta_4} \frac{\partial \theta_1}{\partial x_2} \frac{\partial \theta_4}{\partial x_1} \\
&- \frac{1}{\theta_2 \theta_3} \frac{\partial \theta_2}{\partial x_1} \frac{\partial \theta_3}{\partial x_2} - \frac{1}{\theta_2 \theta_4} \frac{\partial \theta_2}{\partial x_1} \frac{\partial \theta_4}{\partial x_2}
\end{aligned}$$

$$\begin{aligned}
\text{Thus } G_{12} &= \frac{1}{\theta_3} \left[\left\{ \frac{\partial^2}{\partial x_1 \partial x_2} - \frac{\partial \log \sqrt{\theta_1}}{\partial x_2} \frac{\partial}{\partial x_2} - \frac{\partial \log \sqrt{\theta_2}}{\partial x_1} \frac{\partial}{\partial x_2} \right\} \theta_3 \right] \\
&\quad \frac{1}{\theta_4} \left[\left\{ \frac{\partial^2}{\partial x_1 \partial x_2} - \frac{\partial \log \sqrt{\theta_1}}{\partial x_2} \frac{\partial}{\partial x_2} - \frac{\partial \log \sqrt{\theta_2}}{\partial x_1} \frac{\partial}{\partial x_2} \right\} \theta_4 \right] \\
&= \frac{\nabla_{12} \theta_3}{\theta_3} + \frac{\nabla_{12} \theta_4}{\theta_4}
\end{aligned}$$

which defines the Laplacian operator, ∇_{12} of the second kind. If we define similarly ∇_{23} , ∇_{34} , etc. We have,

$$G_{23} = \frac{\nabla_{23} \theta_1}{\theta_1} + \frac{\nabla_{23} \theta_4}{\theta_4}$$

$$G_{34} = \frac{\nabla_{34} \theta_1}{\theta_1} + \frac{\nabla_{34} \theta_2}{\theta_2}, \text{ etc.}$$

The gravitational equations are

$$G_{\mu\nu} - \lambda g_{\mu\nu} = -k \left(T_{\mu\nu} - \frac{1}{2} T g_{\mu\nu} \right) \dots \dots \dots (4)$$

in the usual notation. The six non-principal equations with which we are concerned here are

$$\left. \begin{aligned}
\frac{\nabla_{12} \theta_3}{\theta_3} + \frac{\nabla_{12} \theta_4}{\theta_4} &= 0 \\
\frac{\nabla_{23} \theta_1}{\theta_1} + \frac{\nabla_{23} \theta_4}{\theta_4} &= 0 \text{ etc.}
\end{aligned} \right\} \dots \dots \dots (5)$$

(3) and (5) yield us standard results for the form (1) so that whenever a line-element which is a particular case of (1) comes up for discussion the corresponding relativity equations can be written down straightway without any preliminary tedious calculations such as those of the Christoffel symbols being done.

THE SOLUTION OF $s+ap+bq+cz=o$

Let us consider now the solution of the differential equation

$$s+ap+bq+cz=o$$

$$\text{or } \frac{\partial^2 z}{\partial x \partial y} + a \frac{\partial z}{\partial x} + b \frac{\partial z}{\partial y} + cz = o \dots\dots\dots (6)$$

where a , b and c are functions of x and y . We may write

$$(6) \text{ either as } \frac{\partial}{\partial x} \left(\frac{\partial z}{\partial y} + az \right) + b \left(\frac{\partial z}{\partial y} + az \right) - hz = o \dots (7)$$

$$\text{or as } \frac{\partial}{\partial y} \left(\frac{\partial z}{\partial x} + bz \right) + a \left(\frac{\partial z}{\partial x} + bz \right) - kz = o \dots (8)^*$$

$$\text{where } h = \frac{\partial a}{\partial x} + ab - c, \quad k = \frac{\partial b}{\partial y} + ab - c \dots\dots\dots (9)$$

h and k are known as the invariants of the differential equation (6), If $h=o$

$$\frac{\partial z}{\partial y} + az = Y e^{-\int b dx}.$$

$$\text{or } z e^{\int a dy} = \int Y e^{\int a dy - \int b dx} dy \dots$$

$$\text{or } Z = X e^{-\int a dy} + e^{-\int a dy} \int X' e^{\int a dy - \int b dx} dy \dots (10)$$

where X and Y are arbitrary functions of x and y respectively.

Similarly if $k=o$

$$Z = Y' e^{-\int b dx} + e^{-\int b dx} \int X' e^{\int b dx - \int a dy} dx \dots (11)$$

where X' and Y' are arbitrary functions of x and y respectively. We will now proceed to use the results (10) and (11) to solve the equations (5).

$$\text{The Equation } \frac{\Delta_{12}\theta_3}{\theta_3} + \frac{\Delta_{12}\theta_4}{\theta_4} = 0$$

To solve this equation we first split it into two viz.,

$$\frac{\Delta_{12}\theta_3}{\theta_3} = -C, \quad \frac{\Delta_{12}\theta_4}{\theta_4} = C \dots\dots\dots (12)$$

C may be any function of the four variables and it will be determined later on. The two invariants for the first equation in (12) are

$$h = \frac{\partial a}{\partial x} + ab - C$$

$$k = \frac{\partial b}{\partial y} + ab - C$$

and for the second equation in (12)

$$h' = \frac{\partial a}{\partial x} + ab + C$$

$$k' = \frac{\partial b}{\partial y} + ab + C$$

where $a = -\frac{\partial u}{\partial y}$, $b = -\frac{\partial v}{\partial x}$, $u = \log \theta_1$ and

$v = \log \theta_2$. If $h = 0$, $k' = 0$ we get a solution which is of the same form as the solution when $k = 0$, $h' = 0$. If $h = 0$ and $h' = 0$ simultaneously we get $c = 0$. Consideration of this and the other case $k = 0$, $k' = 0$ which also leads to $C = 0$ gives comparatively trivial results. If $h = 0$, $k' = 0$

$$\frac{\partial a}{\partial x} + \frac{\partial b}{\partial y} + 2ab = 0 \quad (13)$$

$$\frac{\partial a}{\partial x} - \frac{\partial b}{\partial y} = 2c \quad (14)$$

The equations (13) and 14 reduce to

$$\frac{\partial^2 u}{\partial x_1 \partial x_2} + \frac{\partial^2 v}{\partial x_1 \partial x_2} = 2 \frac{\partial u}{\partial x_2} \cdot \frac{\partial v}{\partial x_1} \dots \dots \dots (15)$$

$$\frac{\partial^2 v}{\partial x_1 \partial x_2} - \frac{\partial^2 u}{\partial x_1 \partial x_2} = 2c \dots \dots \dots (16)$$

The solution of (16) is obviously given by

$$\log \frac{\theta_2}{\theta_1} = \int \int 2c \, dx_1 \, dx_2 + Z_{134} \times Z_{234} \dots \dots \dots (17)$$

Z_{134} is an arbitrary function of x_1, x_3, x_4 and Z_{234} of x_2, x_3, x_4 . To

solve (15) assume $\frac{\partial u}{\partial x_2} = \phi$ which reduces the equation

$$\text{to } \frac{\partial \phi}{\partial x_1} + \frac{\partial \phi}{\partial x_2} + 2\phi\phi = 0 \dots \dots \dots (18)$$

where $\frac{\partial v}{\partial x_1} = \psi$ Hence

$$\psi \, e^{-\int 2\phi \, dx_2} = \int \frac{\partial \phi}{\partial x_1} \, e^{-\int 2\phi \, dx_2} \, dx_2 + \gamma_{134}$$

$$\psi = \frac{\partial v}{\partial x_1} - \gamma_{134} e^{\int 2\phi \, dx_2} \int \frac{\partial \phi}{\partial x_1} \, e^{-\int 2\phi \, dx_2} \, dx_2$$

$$= \gamma_{134} e^{2u} - \frac{2u}{e} \int \frac{\partial^2 u}{\partial x_1 \partial x_2} e^{-2u} \, dx_2$$

$$v = \int \gamma_{134} \frac{e^{2u}}{e} dx_1 - \int \frac{e^{2u}}{e} \int \frac{\partial^2 u}{\partial x_1 \partial x_2} \frac{e^{-2u}}{e} dx_2 dx_1 + \gamma_{234} \quad (19)$$

$$\text{or } \log \theta_2 = \int \gamma_{134} \theta_1^2 dx_1 - \int \theta_1^2 \int \frac{\partial_2 \log \theta_1}{\theta_1^2 \partial x_1 \partial x_2} dx_2 dx_1 + \gamma_{234}. \quad (20)$$

Here γ_{134} and γ_{234} have the same meaning as Z_{134} Z_{234} . Thus (17) and (20) together constitute the result of the condition which we have found necessary for solving the equations (12).

We may now write the solutions of the equations (12) by making use of the result (10) and (11).

$$\theta_3 = X_{134} \theta_1 + \theta_1 \int X_{234} \frac{\partial_2}{\partial_1} dx_2 \dots \dots \dots \quad (21)$$

$$\theta_4 = X'_{234} \theta_2 + \theta_2 \int X'_{134} \frac{\partial_1}{\partial_2} dx_1 \dots \dots \dots \quad (22)$$

where X'_{134} is some function of x_1, x_3, x_4 . Similarly for X_{234} X'_{234} etc. As yet X_{134} γ_{234} are all arbitrary. (17), (20), (21) and (22) constitute the result of our investigation of one of the six equations (5).

Treating all the six equations in a similar manner we will get twenty-four conditions connecting $\theta_1 \theta_2 \theta_3 \theta_4$. The problem next is to pick out the most general values of the θ 's possible so as to be consistent with all the conditions.

Assuming that each of the four θ 's is a product of functions of x_1, x_2, x_3, x_4 separately we get a series of solutions of which the most prominent are Lemaître's nonstatic universe and Schwarzschild's solution for a particle.

The above mentioned two solutions satisfy the twelve equations $\nabla_{12} \theta_3 = \nabla_{12} \theta_4 = 0$, $\nabla_{13} \theta_2 = \nabla_{13} \theta_4 = 0$ etc. These twelve equations suggest a geometrical relationship between $\theta_1, \theta_2, \theta_3$ and θ_4 ; for each of the equations is of the form

$$\frac{\partial^2 \phi}{\partial u \partial v} - \frac{\partial \log \sqrt{E}}{\partial v} \frac{\partial \phi}{\partial u} - \frac{\partial \log \sqrt{F}}{\partial u} \frac{\partial \phi}{\partial v} = 0$$

which is satisfied by the rectangular co-ordinates of a point on the surface on which $U = \text{constant}$ and $V = \text{const.}$ are lines of curvature.

SUMMARY

The line element $ds^2 = -\theta_1^2 dx^2 - \theta_2^2 dy^2 - \theta_3^2 dz^2 + \theta_4^2 dt^2$ is discussed taking each θ to be a function of x, y, z, t . Some new solutions are obtained.

TRANSMISSION OF VISIBLE LIGHT THROUGH ARTIFICIAL HOMOGENEOUS CLOUDS

BY

G. R. PARANJPE and N. N. BHAGVAT

INTRODUCTION

The transmission of visible light through fog has been the object of investigation during the last thirty years on account of the increasing application of aviation to commerce. Much of the experimental data on this problem are, however, purely qualitative and the quantitative data that are available admit of little analysis or mutual comparison, each worker having his own conditions of experiment, differing from those of the rest.

Previous work :—

The problem has been studied by Rudolph¹, Haecker², Utterback³, Werner⁴, Granath and Hulburt⁵, Anderson⁶, Houghton⁷, Külb⁸, and Kobayasi and Nukiyama⁹.

The works of Haecker (1905) and Utterback (1919), dependent as they are on the sensitivity curve of the eye, are of little use for generalization. Werner (1923) studied the attenuation of visible light by artificial fog, but he was unable to discover any regularity in the transmission, depending either on the wave-length or the size of the drops. Rudolph (1904) found for natural fogs a feeble increase in absorption with increase in the wave-length in the visible region of the spectrum.

Granath and Hulburt (1929) have made their measurements on natural fogs, using a quartz-spectrograph and a recording densitometer, in the visible part of the spectrum. They also took some measurements in the infra-red region and found a small but gradual increase in transmission for wave-lengths from $\lambda = 4000\text{A.U.}$ to $\lambda = 7000\text{A.U.}$, from where onwards, the transmission remained the same to about $\lambda = 30000\text{A.U.}$

Substantial and detailed is the work of Anderson (1930). He studied artificial fog (water-fogs according to him) in a closed vessel. He was able to produce water-clouds wherein it appears that the sizes of the drops were considerable, but no definite information about the absolute sizes has been given. Moreover, he used hygroscopic nuclei (MgCl_2) to obtain these clouds, which cannot

strictly be regarded as pure water-clouds. In common with Granath and Hulburt, he finds a rise in the transmission towards the red end of the spectrum.

In his work on artificial clouds of water, produced by condensing low-pressure steam, Houghton (1931) found a definite maximum transmission for the wave-length 4900A.U. The total absence of any such maximum in the results of any other investigator led Houghton to believe that the size of the drops in a cloud was one of the controlling factors in the transmission of light. The drops in his clouds ranged between 2 to 3 microns in diameter, and according to him, his clouds must have differed in this respect from those of the other investigators. Since no other investigators have given the size of the drops in their clouds, artificial or natural, this point could not be cleared.

Külb (1931) has studied the problem in great detail but he could neither work on natural clouds on account of unfavourable climate, nor could he produce stable artificial clouds of water; he therefore, worked on artificial clouds obtained from SiCl_4 and NH_3 , TiCl_4 , NH_3 and HCl , etc. These clouds consisted of particles having for their diameter values ranging from 1.2μ to 2.1μ . With particles of this size, he got, for all the clouds he investigated, a maximum absorption for the wave-length 5500A.U. and a minimum absorption for a wave-length between 25000 and 30000A.U. He expected water-clouds also to give similar results, although it does not appear why water-clouds, which are essentially transparent liquid particles, should behave as opaque solid particles like those of NH_4Cl .

Kobayasi and Nukiyama (1932-33) have studied the transmission for clouds of ammonium chloride, water, and mixtures of water and ammonium chloride. For NH_4Cl -clouds they find a sharp maximum transmission for $\lambda = 4500\text{A.U.}$ and negligible transmission below $\lambda = 3100\text{A.U.}$ For water, they get a flat maximum at $\lambda = 3600\text{A.U.}$ and a sharp and much greater maximum at $\lambda = 4780\text{A.U.}$ Clouds of mixtures of NH_4Cl and water exhibit a maximum transmission at 4400A.U. In their study of clouds from incense etc., they get, in the transmission-wavelength curves, two maxima which they attribute to the complex nature of the combustion products.

Present work :—

Though a good deal of experimental work had been done and tentative empirical formulae put forth by some investigators

(Granath & Hulburt and Anderson, for instance, take $I = I_0 e^{-\left(a + \frac{b}{\lambda^4}\right)}$ as a modification of Rayleigh's inverse fourth power law), a strictly theoretical solution of the problem was not forthcoming till

Stratton & Houghton¹⁰ undertook to investigate the problem with a view to see if there was any theoretical justification for Houghton's singular result, viz. a maximum transmission for 4900A.U.

It is this work which has been a source of interest to the present authors and in fact forms the basis of this investigation.

As will be shown presently (p. 33) it is possible to express the transmission as a function of the size of the drops in a cloud and the wave-length under consideration. No workers, in the first place, experimented upon stable clouds of pure water and, in the second place, controlled the size of the drops in their clouds; in point of fact, they have not endeavoured to ascertain the sizes of the drops as they did not expect the transmission to depend on the size of the drops to any very great extent.

Experiments have been going on in this laboratory for the last few years and it has been possible to obtain very stable clouds of pure water-drops, the radii of which could be known and varied within wide limits (1 to 8 microns). The problem of transmission of various wave-lengths in the visible spectrum through clouds, wherein the size of the drops ranged within wide limits, was therefore taken up, and though such a work is generally of a qualitative nature, attempts were made to give it a quantitative significance.

Since the transmission of light depends on the refractive index of the liquid, other liquids have been studied with a view to see how the refractive index affects the transmission characteristics of the liquids and whether these liquids exhibit any similarity to water.

For the first time, thus have pure liquid-vapours been investigated and the effect of the size of the drops on the transmission studied with any degree of accuracy.

Method adopted:—

The clouds were produced in a closed flask by the usual adiabatic expansion method of condensing a saturated vapour. Incense-stick smoke (which consists of very fine particles) was used to provide the nuclei for condensation. The size of the drops was determined by the corona-ring method, which is by far the most suitable method available, and the transmission for different wave-lengths was obtained by employing a sensitive photo-cell in conjunction with a monochromator.

(II)

SOME THEORETICAL CONSIDERATIONS.

In order to see if there was any theoretical justification for Houghton's⁷ result, Stratton & Houghton¹⁰ undertook to treat this

problem theoretically, and following Mie¹¹, Debye¹², & Jobst¹³ in their method of attack in the case of a similar problem, viz. colours of colloidal solutions, they obtained for the transmission ratio :

$$T = e^{-2 \pi n a^2 z K}.$$

where T = the transmission ratio (ratio of the intensities of a constant beam of light after and before passing through the cloud.)

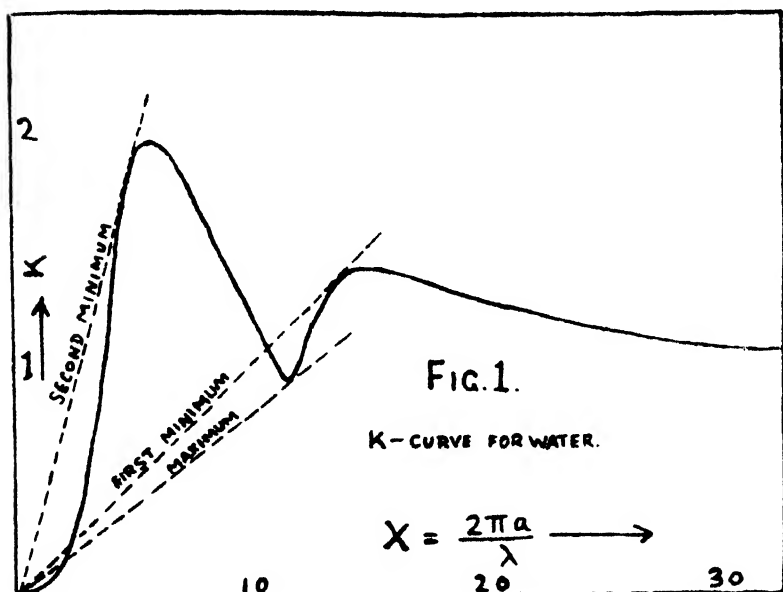
n = the number of drops per cc.,

a = the radius of the drops,

z = the length of the path of the beam through the cloud (the diameter of the flask),

$K = f(2 \pi a / \lambda)$, (where λ is the wave-length), depending on the refractive index of the liquid and therefore, characteristic of the liquid.

Stratton & Houghton have calculated the K -curve for water, It is given here in figure 1.



The above formula for the transmission ratio can be written as

$$T = e^{\frac{-AK}{a}}$$

where A is constant if the quantity of the liquid condensed per cc. is constant. It is to be seen how the nature of the K -curve affects the transmission, if this be plotted as a function of a .

Putting $\frac{K}{a} = y$, we get

$$T = e^{-Ay}$$

Differentiating with respect to a , and putting

$$\begin{aligned}\frac{dT}{da} &= 0, \\ \frac{dT}{da} &= -A \frac{dy}{da} e^{-Ay} \\ &= -AT \frac{dy}{da} = 0.\end{aligned}$$

$\therefore T$ is maximum or minimum when

$$\frac{dy}{da} = 0.$$

Now
$$\frac{dy}{da} = \frac{1}{a} \cdot \frac{dK}{da} - \frac{K}{a^2} = 0.$$

$$\therefore \frac{dK}{da} = \frac{K}{a}, \text{ for } T \text{ to be maximum or minimum.}$$

i. e., when $\lambda = \text{const.}$, $\frac{dK}{dx} \cdot \frac{\partial x}{\partial a} = \frac{K}{a}$, where $x = \frac{2\pi a}{\lambda}$,

i. e.
$$\frac{dK}{dx} = \frac{K}{x}.$$

Thus a maximum or a minimum for a given wavelength is given by the point of contact of the tangent from the origin to the K -curve (Fig. 1). Out of the three tangents that can be drawn from the origin to the curve $K = f(x)$, the two, corresponding to the maxima, give maximum values for K/a and therefore correspond to minimum transmission; while the third tangent corresponding to the intermediate minimum of the K -curve gives a minimum value for K/a and therefore corresponds to a maximum transmission.

If we denote by a_1, a_2, a_3 , the sizes of the drops for which these turning values occur, for any wave-length, we find that these sizes are given by the equation

$$a_m = \lambda x_m / 2\pi \dots\dots\dots (m = 1, 2, \& 3.),$$

where x_m has the three values corresponding to the three points of contact of the tangents from the origin to the K -curve. (Note:— $m = 1$ refers to the flat maximum of the K -curve; $m = 2$, to the minimum; and $m = 3$, to sharp maximum.)

$$\text{Hence } a_1 : a_2 : a_3 :: x_1 : x_2 : x_3 \dots\dots\dots (1),$$

for a particular wave-length.

From the graph of the K-curve for water (Fig. 1) we get the following values of x , for the turning points of the transmission curves :—

$$\begin{aligned} x_1 &= 14, \\ x_2 &= 12, \\ x_3 &= 5, \end{aligned} \quad \text{approximately,}$$

so that, $a_1 : a_2 : a_3 :: 1 : 0.86 : 0.36 \dots \dots \dots (1a)$, gives the ratio of the critical sizes of the drops for water.

If we consider the corresponding turning points of the transmission curves for different wave-lengths, we notice that for each of the above values of x we have

$$\frac{na_m}{\lambda_n} = \frac{x_m}{2\pi} \quad \dots \dots \dots (n = 1, 2, 3, \dots \dots \dots)$$

$$\quad \quad \quad (m = 1, 2, \& 3).$$

where the suffix m refers to the turning point of the transmission curves and the prefix n refers to the wave-length. Thus na_m denotes the radius of drops for which the m th turning point of the transmission-curve corresponding to the wave-length λ_n occurs.

\therefore For a particular value of m ,

$$\frac{na_m}{\lambda_n} = \text{constant} \dots \dots \dots (2).$$

This equation can be put in a convenient form as under :—

$$1^a m : 2^a m : 3^a m : \lambda_1 : \lambda_2 : \lambda_3 \dots \dots \dots (2a).$$

Thus the size of the drops for which the corresponding turning points of the transmission curves occur for different wave-lengths is proportional to the wave-length.

The ideal curves for transmission given in Fig. 2 on the next page, have been plotted from the equation

$$T = e^{-\frac{K}{a}}, \text{ where } a \text{ is expressed in } \mu.$$

This equation is obtained from Houghton's equation in the following way :—

We have

$$T = e^{-2\pi na^2 z K}$$

$$= e^{-\frac{4}{3} \pi a^3 n D \cdot \frac{zK}{Da}},$$

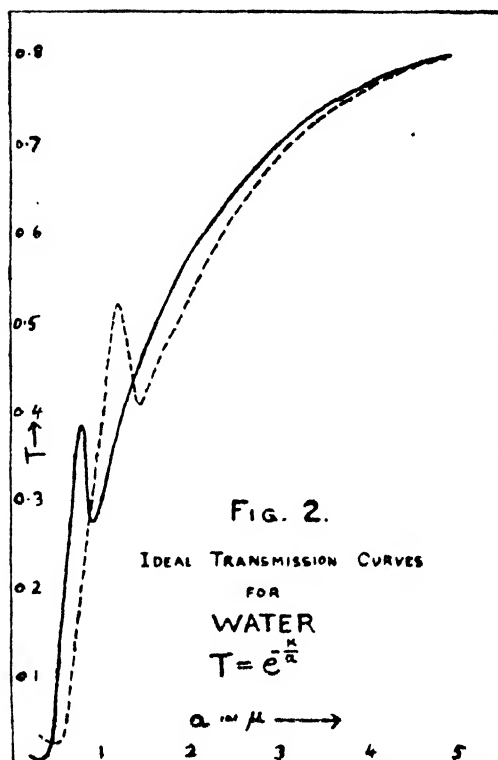
where, D = the density of the liquid = 1, here,

$$= e^{-\frac{4}{3} \pi a^3 n D \cdot \frac{QzK}{a}},$$

where $Q = \frac{4\pi a^3 n D}{3}$, the quantity of the liquid condensed per c.c.

Thus

$$T = e^{-\frac{K}{a}}$$



Full line for 4189 A. U. Dotted line for 6284 A.U.

if we put

$$\frac{3Qz}{2} = 1.$$

Since a has been expressed in μ , z must also be expressed in the same unit. When $z = 30$ cm. (the diameter of the flask in the present investigation), we therefore get

$$Q = \frac{2}{3z} = \frac{2}{3 \times 30 \times 10^4} = 2.22 \times 10^{-5} \text{ gm/cc.}$$

a value within the range of moderate expansion.

Since K is given as a function of $2\pi a/\lambda$, 6284 A.U. is a suitable wave-length in the red region for simplifying the calculations. The other wave-length is taken $\frac{2}{3}$ rds. of this, i.e., 4189 A.U.

The equation $x = \frac{2\pi a}{\lambda}$, now reduces to

$$x = 10a \quad \text{for } \lambda = 6284 \text{ A.U. and we get}$$

$$a_1 = 1.4\mu \text{ (first minimum),}$$

$$a_2 = 1.2\mu \text{ (maximum),}$$

$$a_3 = 0.5\mu \text{ (second minimum), for } \lambda = 6284 \text{ A.U. and}$$

$$\begin{aligned} a_1 &= 0.9 \mu ; \\ a_2 &= 0.8 \mu ; \\ a_3 &= 0.3 \mu ; \end{aligned} \quad \text{for } \lambda = 4189 \text{A.U.}$$

It is also evident from fig. 2 that for values of a greater than 5μ , both the wave-lengths have the same transmission.

The verification of the above results has been carried out by designing suitable experimental arrangements and it is this work which forms the subject matter of the present paper. The paper describes various arrangements

- (1) to keep the quantity of water condensed per cc. constant,
- (2) to obtain clouds, which, though individually uniform, consist of drops whose size varies considerably from cloud to cloud, and
- (3) to determine the size of the drops and the transmission of light of various wave-lengths through these clouds.

The transmission is then plotted as a function of the size of the drops in a cloud for each wave-length and these curves are compared with those given by the theory.

Before concluding these considerations however, it is to be remarked that the ideal curves do not point to the well-known law of the inverse fourth power of the wave-length when the values of a are small in comparison with the wave-length of light. It appears that this requires perfectly opaque particles, and the conclusion that Mecke¹⁴ has drawn about small drops that they do not behave as opaque discs seems to be justified.

III

EXPERIMENTAL ARRANGEMENTS AND GENERAL METHOD OF WORK.

Expansion Chamber :—

The arrangements were generally similar to those described before by Paranjpe, Mirchandani and Naik¹⁵. The flask, in which the clouds were produced, had a capacity of about 10 litres and was kept in an enclosure having four windows in its four sides. Two independent sources of light could thus be used, one for the determination of the size of the drops from the corona-ring measurements and the other to give the parallel beam of light required in the intensity determinations. An air-tight metal tank about four to five times larger than the flask was used for creating sudden expansion in the flask. The area of the bore of the tap connecting the tank and the flask was about one sq. cm. The pressures inside the tank and the flask could be read by means of two separate manometers.

The quantity of any liquid condensed as a result of an adiabatic expansion is a function of (1) the room temperature, (2) the atmospheric pressure, and (3) the final pressure in the flask after the expansion. In order, therefore, to keep the quantity of the condensed

liquid constant, all these three factors must be kept constant. This was achieved in the following way :—

For each set of experiment, the atmospheric pressure and the room temperature were observed, before and after, due care being taken to carry our experiments under as identical conditions as possible. The final pressure in the flask could be kept constant by putting the flask adiabatically in communication with the metal tank, wherein the pressure was brought down before each expansion to the same lower value by means of an exhaust pump.

The expansion could not be regarded as fully adiabatic but so long as the initial and final pressure in the flask remained the same in any expansion, the quantity of the liquid condensed would still remain the same, though it might not be equal to that calculated on the assumption of a full adiabatic expansion.

Measurement of the size of the drops :—

The size of the drops was determined by the usual corona-ring method. The source of light for the corona-rings was a 1000-watt electric lamp (lamp A) and the light of this lamp was brought to a focus at a distant point so that the beam of light incident on the flask could be regarded as parallel for most purposes.

The angular diameters of the corona-rings were measured by means of a theodolite. The distance at which the theodolite is kept from the flask is immaterial so far as the determination of the angular diameter of the corona-ring is concerned, since the angle subtended by a corona-ring is the same at all distances (if the beam of light is really parallel). This distance however sets a limit to the maximum angular diameter measurable (which is in fact equal to the angle subtended by the diameter of the flask at the theodolite). In order therefore to be able to measure large rings the theodolite was kept inside the enclosure very near to the flask. The rings measured in this manner are due to rays less divergent than those responsible for the same rings when the theodolite is kept at a distance ; for when the theodolite is close to the flask it is directed to particles nearer to the centre of the flask. In fig. 3, the circle represents the flask and O, O' represent two positions of the theodolite.

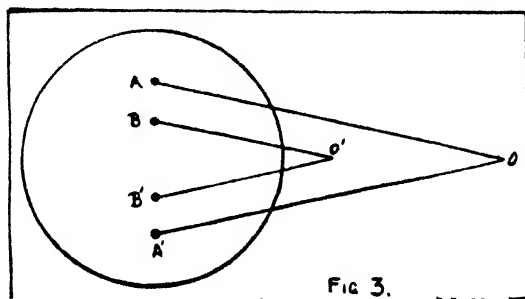


FIG 3.

When the theodolite is kept at O, the ring is due to drops, A, A'. When the theodolite is brought at O' nearer to the flask, the same ring is due to drops B, B'. Thus the ring in the latter case is due to rays nearer to the axis and therefore less divergent. The same thing will be also evident from the following note:—

A note on the verification of Stokes' law:—

Paranjpe, Mirchandani and Naik¹⁵ determined the size of the drops from that of the corona-ring and obtained the velocity of fall of the cloud by noting the time taken by the well defined top of the cloud to move down a known distance. Their results give a mean value of 2.04 for V'/V , where V' represents the velocity calculated from Stokes' law for the particular size of the drops, and V the observed velocity. This deviation from the law was attributed to the mutual influence of the drops and the influence of the sides of the vessel.

Since V as well as V' is proportional to the square root of the radius of the drops, the value of the radius obtained from the ring measurements was about 1.4 times that obtained from Stoke's law. This discrepancy occurred invariably when the theodolite was kept at a distance of about a metre or so from the flask. But on removing the theodolite nearer to the flask this ratio ultimately reduced to about 1.1, the ring measurements being more accurate, as the rings were now due to rays nearer to the axis (and therefore less divergent.)

A rough idea about the closeness with which the particles were packed together in these clouds can be obtained from the following simple calculations:—

If there be n drops per cc., each of volume v , and if Q be the quantity of water condensed per cc. we have

$$(D) \quad nv = Q, \quad D = \text{the density} = 1, \text{ here,}$$

and $nV = 1$, where V is the space occupied (not filled) by each drop.

$$\therefore \frac{V}{v} = \frac{1}{Q}.$$

Since Q never exceeded 5×10^{-6} gm/cc. in these experiments, even on the assumption of a full adiabatic expansion, the least value of

$$\frac{V}{v} = \frac{10^6}{5} = 2 \times 10^5,$$

Or, if we want the ratio $\frac{d}{a}$, where d is the distance between the centres of the drops and their radius, we have

$$(D) \frac{4 \pi a^3 n}{3} = Q$$

$$\text{and} \quad d^3 n = 1$$

$$\therefore \quad \frac{d^3}{a^3} = \frac{4 \pi}{3Q} = \frac{4 \pi \cdot 10^6}{3 \cdot 5}$$

$$\text{i. e.} \quad \frac{d}{a} = \left(\frac{88}{105} \right)^{\frac{1}{3}} \times 100 = 95 \text{ (approx.)}$$

It is thus seen that the drops were so far apart as not to be able to exert any influence on the surrounding drops. The slightly low value of the observed velocity of fall was due to the sides of the flask. The cloud, when falling, moved faster in the centre than at the edge, as was evident from the slight depression in the middle of the cloud. It was not possible to measure the velocity of this central part and one had to be content with the measurement of the velocity at the edge.

A further improvement in the measurement of the angular diameter of the rings was made by attaching a pointer to the theodolite. This pointer was fixed into the tube for the base-scale eyepiece and rested on the moveable disc of the theodolite and was carried along with it by a screw projecting upwards from it, when it was turned one way; and when the disc was turned the other way, the pointer remained in its extreme position and the disc turned alone. By this self-recording arrangement quick measurements were rendered possible.

When observed through a coloured glass filter, bright diffraction rings appear separated by dark ones. The larger the dark ring thus observed the greater is its width and the dimmer it becomes. The present measurements were, therefore, made with blue rings without using any coloured glass filter. Consequently, the size of the drops was determined from the following formula corresponding to a maximum intensity (Humphrey's Physics of the Air, page 528):—

$$\sin \theta = \frac{m \lambda}{2 \pi a} \quad \text{where,}$$

θ = angle subtended by the radius of the corona-ring at the eye of the observer,

λ = mean wave-length of light forming the corona-ring,

a = average radius of the drops.

Since the first blue ring was always observed the value of $\frac{m}{\pi}$ was

taken to be 0.819 which corresponds to the first maximum. The average wave-length was taken to be 4600A.U.

The appearance of corona-rings is evidently an indication that the clouds consist of uniform droplets. Further, the following method was adopted in obtaining clouds, having drops of different sizes :—

A certain number of nuclei was once for all introduced into the flask. Condensation did not take place on all the nuclei but only on a fraction (perhaps a definite fraction) of the available nuclei. As the cloud settled, some of the nuclei went down into the liquid and the number of available nuclei thus decreased. As a result of this, at each successive expansion the size of the drops became greater and greater since the number of nuclei went on decreasing while the quantity of liquid condensed remained the same.

The extent to which the radii of the drops could be measured ranged from 1 to 8 microns.

According to Mecke¹⁴, the formula for the determination of the size of the drops from the corona-measurements does not hold good for drops less than 4μ in radius ; the smaller drops do not behave as opaque circular discs and therefore the refractive index of the liquid must be taken into account. A greater ring, however, does necessarily correspond to smaller drops and though the ring-measurements may not give us the exact size of the drops, for comparative measurements they are none the less useful.

Measurement of the intensity of light :—

A very sensitive photo-cell was employed in these measurements and consequently, a lamp working on 230-volts D. C. supply mains could not be used on account of the fluctuations in its intensity. A 500-watt electric lamp (lamp B), working on a 120-volt independent steady battery was therefore used as the source of light. The light of this lamp was brought to a focus at a very distant point. The light after passing through the flask travelled along the axis of a metal cylinder about 33 cm. in length and 11 cm. in diameter. The inside of this cylinder was blackened. At its end facing the flask this cylinder carried a disc, having a central aperture nearly 1.5 cm in diameter. The further end of the cylinder carried a big lens of about 25 cm. focal length. With this lens the central parallel beam of light could be focussed on the slit of a monochromator, which was used to isolate different regions of the visible spectrum. The photo-cell was mounted in a wooden box having a small window through which it received the monochromatic radiation. The box of the photo-cell was coated on the outside with wax to prevent leakage. The observations were carried out in a dark room and the photo-cell box

as well as the monochromator was covered by a black cloth to cut out stray light.

The diagrammatic layout of the apparatus as seen from above is given in fig. 4.

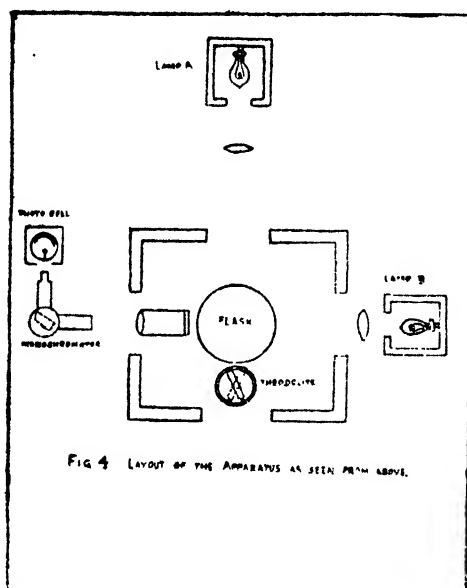


FIG 4 LAYOUT OF THE APPARATUS AS SEEN FROM ABOVE.

The photo-electric current was amplified by means of a one-stage direct current vacuum-tube amplifier. The circuit is shown in fig. 5.

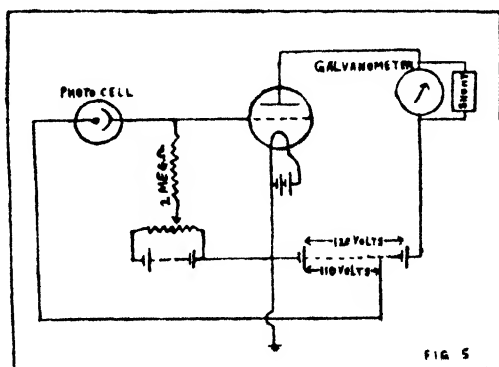


FIG 5

The galvanometer was shunted by a resistance of about 0.2 to 0.4 ohm, so that it was rendered dead-beat and the deflection did not go beyond the scale. Lamp and scale were used to magnify the deflection. The scale was kept at a distance of about 4 metres from

the mirror of the galvanometer (this mirror was concave and a fine sharp image of a filament of the lamp could be focussed on the scale). The scale was about half a metre long and was divided into 700 parts. The measurements were taken correct to 5 divisions, so that the values of the transmission-ratio were correct to about 2%. (Note :—The ratio of the intensity of the light after passing through a cloud to its original intensity is called the transmission ratio and is given by the ratio of the deflections of the galvanometer with and without the cloud in the flask, the intensity of the beam being regarded as proportional to these deflections).

As the photo-cell was not equally sensitive to all colours, being in fact far more sensitive to the red than to the blue light, a rheostat was included in the circuit of the lamp B and the resistance was so controlled as to have almost a full scale deflection for all the wave-lengths used. The following mean wave-lengths were chosen for this investigation :—4600, 5100, 5600, 6100, and 6600 A. U.

A TYPICAL EXPERIMENT

As has already been remarked the atmospheric pressure and the room temperature were noted, before and after each set of experiments ; variations of a few millimetres, in the pressure, and changes in the temperature of about half a degree at the most, were found to take place ; but they were inevitable and to avoid any error on their account, in some cases a fairly large number of observations was taken and in others the measurements were made as quickly as possible, so that the whole set was completed before any appreciable change in the temperature and pressure had taken place. These variations were, however, small and their effect could be neglected.

The monochromator was then arranged so that the beam was sharply focussed on its slit. The photo-cell box was kept in its proper position and both the monochromator and the photo-cell box were then covered by a black cloth.

A trial intensity measurement was then taken in the following way :—

The grid-bias rheostat was first so adjusted that the galvanometer pointer was at one end of the scale ; the lamp B (the one for intensity measurements) was then switched on to see what deflection was obtained ; if the deflection was not full-scale, the shunt of the micro-ammeter was changed, the G. B.-rheostat readjusted and again the deflection noted. This process was repeated until a full-scale deflection was obtained.

Observations were always started with the wave-length 4600 A. U., for which the photo-cell was least sensitive and the lamp

required its full current to give a large deflection. Longer wavelengths were then taken up one after another, the intensity of the lamp being regulated by the rheostat, the adjustment of the G. B.-rheostat and the shunt of the micro-ammeter remaining thus the same for all wave-lengths.

The tank was then partially evacuated and a small expansion made in the flask. Nuclei from burning incense-stick were then admitted into the flask along with the outside air. When liquids other than water were worked upon, an altogether different process of introducing the nuclei and the liquids had to be adopted. The pressure in the tank was brought down to a definite value which was indicated by the manometer attached to the tank.

The amplifier was again switched on, and the position of the pointer of the galvanometer noted. The lamp B was then switched on and off a few times to see if the readings of the pointer were reproducible. When this was found to be the case the positions of the pointer with the lamp B off and on were noted; while the lamp was still burning the expansion was made by quickly opening and closing the tap connecting the flask and the tank. The time required for this operation can be regarded as almost the same for each expansion, the constancy being, in fact, a function of the training of the hand. The new position of the galvanometer pointer was noted, the lamp B was switched off, and the lamp A switched on. The operation of switching off the first lamp and switching on the second was done by one and the same switch, the lamps working on two independent batteries. The theodolite was rotated one way (in the way in which the pointer attached to the theodolite was carried by the rotating disc along with it), and then the other way, directing the telescope-tube of the theodolite each time to the centre of the first blue ring. The tube of the telescope carried cross-wires at its end facing the flask and the rings were observed through a fine hole in an ebonite piece, which was substituted for the eyepiece. The lamp A was switched off first and then the amplifier. The readings of the base-scale of the theodolite could then be taken at leisure. The interval between the moment of expansion and the final setting of the theodolite was hardly ten seconds (this was possible after some practice) and both the measurements (for the determination of the size of the drops and of the transmission ratio) could be regarded as almost simultaneous.

(IV).

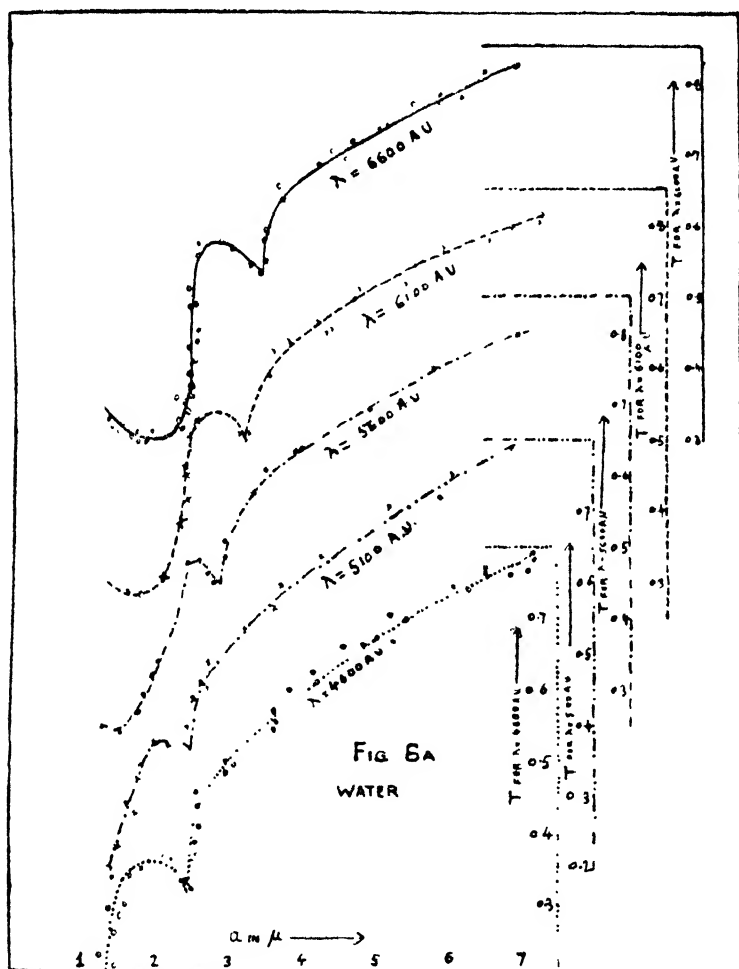
WATER.

Since data, both experimental and theoretical, are available in the case of water, this liquid has been studied in detail. Other

liquids then follow, results in each case being compared with those of water.

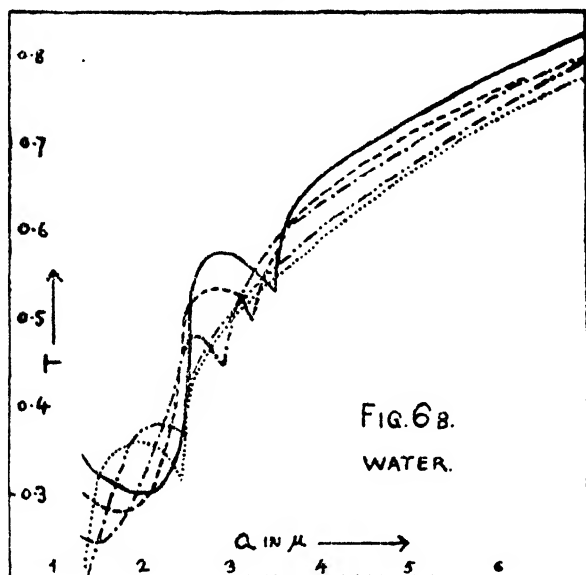
Graphs have been plotted to represent the transmission as a function of the size of the condensed drops. Graphs for water are given in fig. 6 A and B.

In fig. 6 A, the ordinate is shifted up successively and is given against each curve on the right-hand side.



It can be seen from the graphs that though the curves show the maximum and minima, these turning points do not occur at the expected values of the size of the drops. Further large drops appear to transmit red light better than blue, in contradiction with the theory (vide fig. 2). The graphs do not meet at

$a=5\mu$, as in fig. 2, but show only a slight tendency to meet even at $a=7\mu$. The curves do not show sharp turning points (excepting the first minimum). This may be attributed in the first place to the fact that the ideal curves correspond to strictly monochromatic light



whereas in the present work the beam had a dispersion of about 100 A.U. and in the second place, the clouds have been supposed to consist of uniform droplets whereas there might have been a certain number of drops having different sizes. The first minimum could have been rounded off but it is drawn sharp to show the experimentally observable difference between it and the other two turning points.

Before taking up a detailed discussion of the results obtained in the case of water, it will be useful to survey the theory and its limitations briefly.

Development and limitations of the theory :—

Whenever the phenomena resulting from an incident electromagnetic radiation are to be studied macroscopically the whole process is split up into reflection and refraction on one side and scattering on the other, and each item is studied separately. Such considerations are, therefore, made for small particles to begin with.

If the particles are very small as compared to the incident wavelength, the scattering alone need be considered, and we obtain the well-known relation due to Rayleigh. If, however, the drops are not

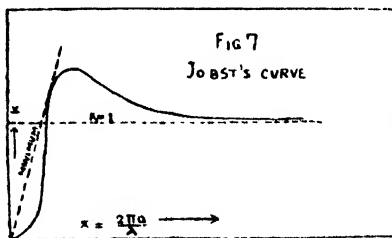
small in comparison with the wave-length, the effect due to scattering may be neglected since reflection and refraction play a prominent role in this case. Wiener¹⁶, Mecke¹⁴ and Pokrowski¹⁷ tried to solve this problem on certain assumptions, which rendered their considerations valid only in special cases; their results are not applicable when the sizes of the particles are of the same order of magnitude as the wave-length.

Mie¹¹ has carried out an exact calculation of scattering and absorption on the ground of the electro-magnetic theory of light. These calculations hold good for any size of the particle and for any value of the wave-length, the only objection to these calculations being the extension of the physical constants obtained from macroscopic investigations to the microscopic particle under consideration. The application of his formula is rendered very elaborate on account of the numerous difficulties encountered in the calculations. Consequently, investigators who undertake to verify Mie's theory restrict themselves to cases where the ratio of the size of the particle to the wave-length can be regarded as small.

If the sizes of the particles are of the same order of magnitude as the wave-length, Mie's theory can be rendered applicable in two different ways:

- (i) the calculations are simplified by using suitable tables; or
- (ii) easily calculable expressions are obtained by suitably transforming Mie's formula.

Blumer¹⁸ has followed the first method and calculated the scattering by particles 0.5μ to 1.0μ in diameter. The second method has been followed by Debye¹², Jobst¹³ and others. Jobst, in particular, succeeded in calculating the total scattered or absorbed light for any ratio of the diameter of the particle to the wave-length. Fig. 7 shows the curve obtained by Jobst.



This curve gives the relation between the scattered light and the size of the particle and the wave-length. The size of the particle remaining the same, the absorption first increases with decreasing wave-length very steeply, becomes flat very rapidly and attains a

maximum and then has a feeble slope and an asymptotic approach to the ordinate $K = 1$. From this curve it is seen that for a particular size of the particle, only one wave-length will have a minimum transmission.

Stratton and Houghton¹⁰ followed Jobst very closely but they investigated the region of small values of $x = 2\pi a/\lambda$ and obtained in addition to the maximum of Jobst's curve one more maximum, which is much flatter, and a minimum between these two maxima (vide fig. 1,). The consequence of this is that for a particular size of the particle, there would be a minimum transmission for two wave-lengths and a maximum transmission for some intermediate wave-length.

Jobst and later Stratton and Houghton have carried out their calculations only for a perfectly or very nearly perfectly conducting particle. This restriction is due to the fact that the introduction of a finite value of conductivity brings in along with it difficulties of calculations. In the absence of an accurately worked out K-curve, a prediction about the nature of scattering and absorption in a particle having finite conductivity is impossible to make.

These considerations hold only for a single particle. When a number of particles are present, as in a cloud, the effect of the neighbouring particles will have to be taken into account. There may be, for example, multiple scattering and interference taking place and it is difficult to say how these would affect the transmission.

A comparison of the results obtained in this investigation with those of other workers and with the theory may now be taken up. The experiments can give results which make it possible to have only a qualitative comparison with the theory; for the theory deals with a single perfectly conducting particle whereas results to be compared have been obtained from measurements on a collection of particles having a finite conductivity.

Comparison of experiment with the theory :—

Of all the works mentioned in the beginning those of Külb⁸ and Houghton⁷ are useful for comparison, since they have given the sizes of the particles in their clouds. It is possible to indicate what the size of the particles in the clouds of the rest of the investigators might have been, but it is of little use to do so, since there would be no verification for the same. Kobayasi & Nukiyama⁹ obtain, in the case of water, results similar to those of Houghton and we may assume (though they have not given the size of their particles) that the size of their particles was the same as that of Houghton's.

Külb has worked on artificial clouds of opaque particles such as NH_4Cl etc. His results may, therefore, be expected to show only a similarity but no agreement with the results obtained with water drops. This is found to be the case. He got a maximum transmission between $\lambda = 25000$ A.U. and $\lambda = 30000$ A.U., and a minimum transmission for $\lambda = 5500$ A.U., for all the clouds he investigated. He tries to explain his results with the help of Jobst's curve (fig. 7). The minimum in his results could be explained by this curve but not the maximum. He was, however, able to show that Blumer's¹⁸ results indicated the existence of more than one turning points in the transmission-wavelength curves and that his result was, therefore, not surprising. The maximum in the infra-red was, according to him, due to some unknown causes, quite distinct from those responsible for the minimum in the visible region. Houghton's curve (fig. 1), however, not only explains Külb's maximum but also predicts a minimum in farther infra-red. Külb has not gone beyond $\lambda = 42000$ A.U. and this prediction cannot, therefore, be verified at present.

Kobayasi & Nukiyama⁹ obtained in the case of NH_4Cl clouds a sharp maximum transmission at $\lambda = 4580$ A.U. in contrast to Külb's minimum at $\lambda = 5500$ A.U. and maximum at $\lambda = 26000$ A.U. This disagreement might be due either to an extraordinary difference in the particle-size in the two cases or to the non-uniformity of the particles employed by Kobayasi & Nukiyama. Houghton's curve cannot explain both the maxima since it admits the existence of only one maximum.

In the case of water they get two maxima of transmission, a weak one for $\lambda = 3600$ A.U. and a sharp one for $\lambda = 4780$ A.U. This shows that the clouds of water in their experiments must have contained quite an appreciable percentage of drops having a size smaller than that responsible for the second (sharp) maximum. Similarly in the case of smokes from incense etc. they obtain two maxima which must also be due to the same cause.

Houghton⁷ obtained a maximum transmission for $\lambda = 4900$ A.U. The drops in his clouds were 2 to 3 microns in diameter. He has calculated the size of the drops for which there would be a maximum transmission at 4900 A.U. according to his curve. He gets for the diameter of the drops a value of 1.7μ . Thus the ratio of the observed to the calculated value of the size of the drops comes out to be about 1.2 to 1.8. The observed values have, therefore, a considerably greater magnitude than that given by the theory.

Instead of varying the wave-length and keeping the size of the

drops the same, in the present investigation, the wave-length was kept constant for one curve and the size of the drops was varied.

The verification can be effected as follows:—

(1) Verification of equation (1a),

(2) " " " (2a),

& (3) " " the absolute magnitudes of the drops at which the maximum and the minima of the a-T curves occur for different wave-lengths.

(1) & (2) are represented by tables 2-3 below. These have been obtained from table 1, which gives the values of n_{am} (vide fig. 6A) (n_{am} denotes the radius of the drops at which occurs the m th turning point of the a-T curve corresponding to the wave-length λ_n).

TABLE 1.

		Min. 1.	Max.	Min. 2
n	λ_n in A. U.	n^a_1	n^a_2	n^a_3
1	6600	3.5	2.9	2.0
2	6100	3.2	2.8	1.8
3	5600	2.9	2.6	1.4
4	5100	2.5	2.2	?
5	4600	2.4	2.0	?

TABLE 2

λ in A. U.	6600	6100	5600	5100	4600	
	Observed.					Calculated.
$\frac{n^a_2}{n^a_1}$	0.83	0.87	0.90	0.88	0.83	0.86
$\frac{n^a_3}{n^a_1}$	0.57	0.55	0.48	?	?	0.36

TABLE 3

n	$\frac{n^2 a_1}{l^2 a_1}$	$\frac{n^2 a_2}{l^2 a_2}$	$\frac{n^2 a_3}{l^2 a_3}$	$\frac{\lambda_n}{\lambda_1}$
2	0.92	0.96	0.90	0.93
3	0.83	0.89	0.70	0.85
4	0.71	0.76	?	0.77
5	0.68	0.69	?	0.70

It is thus clearly seen that the relations (1a) and (2a), are fairly well satisfied, with the exception of the high experimental values for $\frac{n^2 a_3}{n^2 a_1}$, (Table 2). This exception is probably due to the theoretical value for the ratio being too small on account of the considerably low value of $x = 5$ to which $n^2 a_3$ corresponds. As will appear later there is much divergence between theory and experiment at this value of x ($= 2\pi a/\lambda$).

Table 4 gives the values of the sizes of the drops for which the turning points (in the transmission-radius curves fig. 6A,) ought to occur, according to theory.

TABLE 4

n	λ_n	$n^2 a_1$	$n^2 a_2$	$n^2 a_3$
1	6600	1.47	1.26	0.52
2	6100	1.36	1.16	0.48
3	5600	1.24	1.07	0.44
4	5100	1.14	0.97	0.41
5	4600	1.02	0.88	0.37

A comparison of these values with those of Table 1 will show that the third part of the verification is not at all satisfied. This discrepancy between the observed and calculated values of $n^2 a_m$ can

be suitably represented by the ratio of these values. Table 5 gives these ratios for different wave-lengths.

TABLE 5

λ in A. U.	$\frac{o^a_1}{c^a_1}$	$\frac{o^a_2}{c^a_2}$	$\frac{o^a_3}{c^a_3}$
6600	2.34	2.33	3.85
6100	2.38	2.44	3.75
5600	2.32	2.42	3.18
5100	2.19	2.26	?
4600	2.35	2.27	?

It is seen that the values of the ratio in the second and the third columns of this table are nearly the same and fairly constant, showing a slight tendency to decrease with the wave-length. The values in the fourth column are rather too high but they show a definite and much greater tendency to decrease with the wave-length. The ratios in the first two ratio-columns are higher than 1.8, which is the maximum value of the same ratio for the particles in Houghton's clouds. As the value of the size of the drops in a cloud goes on increasing, the condition necessary for approximate calculations (viz. that the value of x should be small) goes on being more and more violated. Already when the drops are 2 to 3 microns in diameter, the ratio attains a maximum value of 1.8; it is no wonder, therefore, that a value as high as 2.4 is obtained for the same ratio with drops 2.6 to 14.4 microns in diameter.

The considerably high value (3.8-3.1) in the last column of Table 5 may partly be due to the fact pointed out by Mecke¹⁴ that small drops do not behave as opaque discs and that the determination of the size of the drops from corona rings is, therefore, uncertain when these drops are small; yet it is not possible to say how much credit may be given to this fact in raising the above values. These high values correspond to $x=5$. Had Houghton carried out his investigations in the infra-red as well, he would have, according to the theory, obtained a minimum transmission for some wave-length. It would have then been possible to determine the size of the drops from this wave-length and from this, the ratio of the

observed to the calculated value of the size of the drops. This ratio would have corresponded to $x = 5$, and it would have then appeared how much the high values owe to $x = 5$ and how much to Mecke's hypothesis. In the absence of the required data nothing can be said definitely. There are, however, some points which show that these high values are due to 5 being probably too low a value of x , at which the third turning points occur:—

- (1) The value 1.1 obtained for the ratio of the sizes of the drops determined by the corona ring method and from the law of Stokes was found to be practically the same for all the sizes of the drops (1 to 8 μ in radius).
- (2) There is practically complete agreement between theory and results, so far as verification (2) is concerned (vide Table 3.). This verification is independent of the values of x .
- (3) The ideal curves for transmission (fig. 2,) do not show agreement with Rayleigh's theory when the size of the drops is small in comparison with wave-length (i.e. when x is small).

In order to verify Mie's theory, investigators generally restrict themselves to particles small in comparison with the wave-length. Blumer tried to extend the work to particles 0.5 to 1.0 microns in diameter. Külb carried out the extension to particles 1.2 to 2.1 microns in diameter; Houghton's particles were 2 to 3 microns in diameter; and the particles in the present work ranged between 2.6 and 14.4 μ in diameter. Külb found that though his curves could be explained with the help of some of Blumer's calculations, in general there was no agreement between his results and Blumer's. Similarly though Houghton's results agree in a general way with those of the present work there is an appreciable difference in details. It is, therefore, difficult to decide whether this disagreement between the theory and the experiment is due to the incompleteness either of the theory or of the calculations or due to the extension of physical constants obtained from macroscopic observations to microscopic particles or due to all these put together.

In conclusion it may be remarked that one can only try under the present circumstances, to indicate a possible connection between theory and experiment. An extension of the theory and its verification by experiment is only too desirable and perhaps only then will the points be cleared up that to-day seem to be obscured by want of definite knowledge about the processes that occur when an electromagnetic radiation is incident on a multitude of non-conducting

particles having size much greater than that of the incident wavelength.

(V.)

OTHER LIQUIDS.

Other liquids are now taken up one by one and each is dealt with separately and compared with water.

The following typical liquids have been chosen :—

	Relative density.	Refractive index.
1. Chloroform	1.50	1.45
2. Carbon Tetrachloride	1.59	1.46
3. Kerosene	0.82	1.45
4. Alcohol (Ethyl)	0.79	1.36
5. Toluene	0.87	1.50
6. Aniline	1.02	1.59

PRELIMINARY ARRANGEMENTS.

Introduction of liquids into the flask :

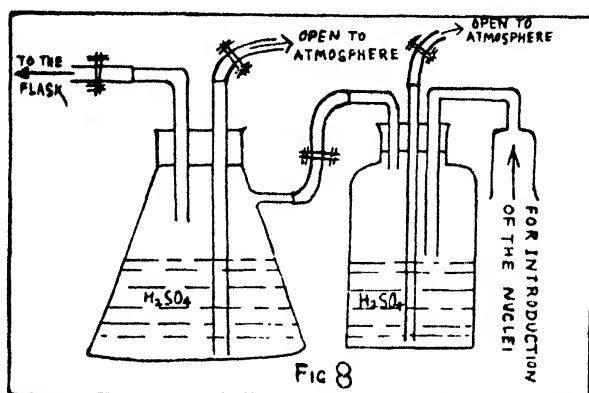
When liquids other than water are to be used in the flask, a precaution is necessary. Not only must the air that is admitted to the flask after each expansion (to bring the pressure upto that of the atmosphere) be free from water vapour but also the flask should not contain any water vapour before the introduction of the liquid. The quantity of water vapour ordinarily present in the air is quite sufficient to vitiate the results. In the first place, the cloud becomes heterogeneous and most unsteady ; and in the second, most of the drops are composed of water.

In order, therefore, that there should not be any initial quantity of water vapour in the flask at the time of the introduction of the liquid, the air inside the flask was pumped out several times and its place was filled with outside air after passing it through strong sulphuric acid. When the flask was thus practically completely freed from water vapour, which fact could be ascertained from the absence of condensation even for a very large value of the expansion, the liquid was introduced into the flask by a tube (not shown in fig. 4) passing through the cork, the principle of syphon being employed. This arrangement is also useful in adding fresh quantities of liquids without removing the cork, if the liquids are volatile.

Introduction of the nuclei, keeping out water vapour :

In order to ensure that no water vapour entered the flask when the nuclei obtained by burning incense stick were introduced, the following arrangement was adopted :—

The nuclei were first introduced in a small bottle containing strong sulphuric acid; here they were allowed to remain for some time. Air was then drawn into the bottle through the acid and the nuclei were thus carried into the flask by a current of dry air. The communication between the bottle and the flask was made through an additional vessel containing strong sulphuric acid. Dry air free from nuclei could also be thus admitted to the expansion chamber whenever required. The diagram of the arrangement is given in fig. 8.



Note:—For each liquid, the magnitude of expansion was determined by trial, so that the quantity of the liquid condensed was neither too great nor too small. This was done by obtaining the transmission ratios for different densities of clouds.

CHLOROFORM.

Fig. 9 gives the transmission-curves for Chloroform.

The curves are similar to those for water in all respects.

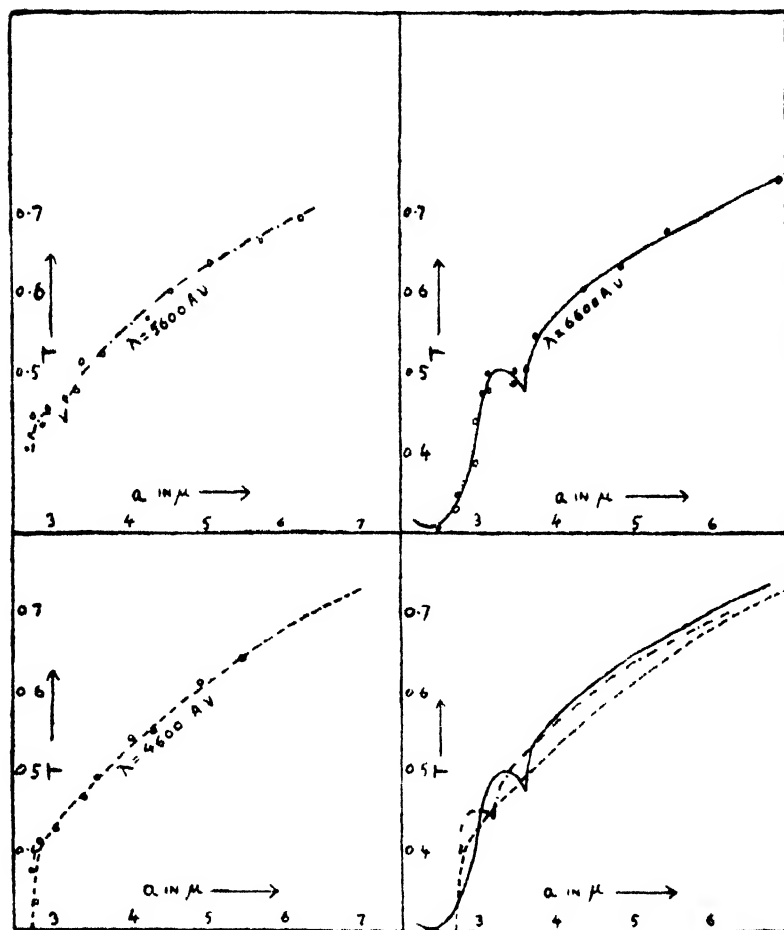


FIG 9 CHLOROFORM.

Table 6 gives the values of n_a .

Tables 7-8 represent verifications (1) & (2) respectively.

TABLE 6

n	λ_n	n^{a_1}	n^{a_2}	n^{a_3}
1	6600	3.60	3.30	2.30
2	5600	3.20	2.90	?
3	4600	2.70	?	?

TABLE 7

λ	6600	5600	Experimental values for water :—
n^{a_2} n^{a_1}	0.91	0.90	
$\frac{n^{a_3}}{n^{a_1}}$	0.64	?	

0.86

0.53

TABLE 8

n	$\frac{n^{a_1}}{1a_1}$	$\frac{n^{a_2}}{1a_2}$	$\frac{\lambda_n}{\lambda_1}$
2	0.89	0.88	0.85
3	0.75	?	0.70

The results are thus in agreement with the theory.

CARBON TETRACHLORIDE

Fig. 10 gives the transmission curves for CCl_4 .

The curves are similar to those for water in all respects.

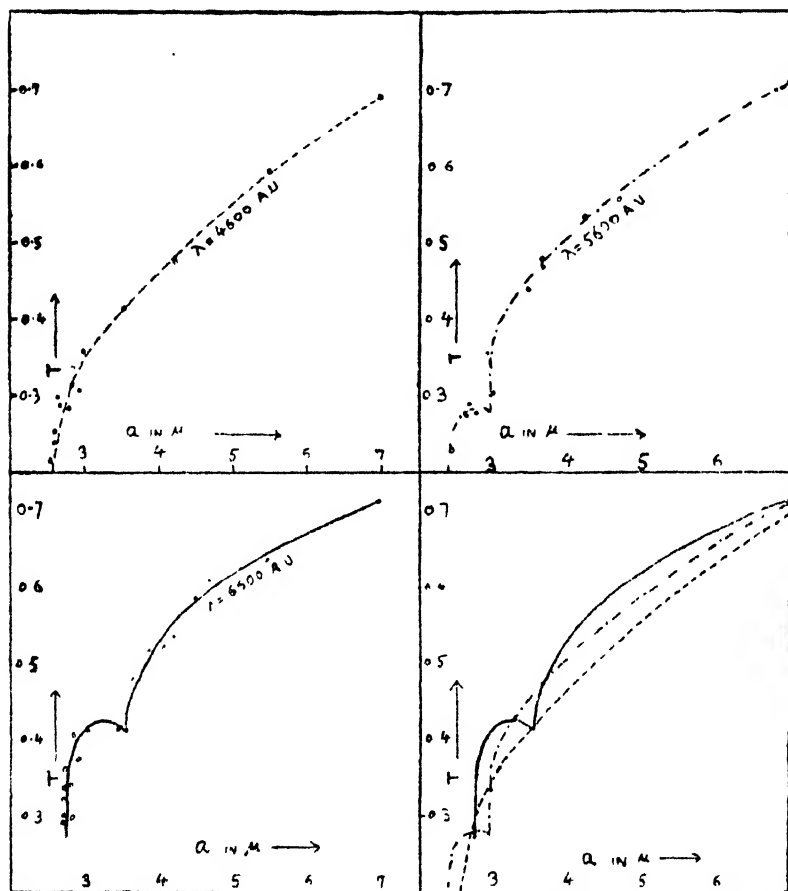


FIG. 10 CARBON TETRACHLORIDE.

Table 9 gives the values of n_m .

Tables 10-11 represent verifications (1) & (2) respectively.

TABLE 9

n	λn	n^a_1	n^a_2
1	6600	3.50	3.25
2	5600	2.95	2.8
3	4600	2.50	?

TABLE 10

λ	6600	5600
$\frac{n^a_2}{n^a_1}$	0.93	0.95

Experimental value
for water :—

0.86

TABLE 11

n	$\frac{n^a_1}{1^a_1}$	$\frac{n^a_2}{1^a_2}$	$\frac{\lambda n}{\lambda_1}$
2	0.84	0.86	0.85
3	0.71	?	0.70

The results are thus in agreement with the theory.

KEROSENE.

Fig. 11 gives the transmission-curves for Kerosene.

The curves are similar to those for water in all respects.

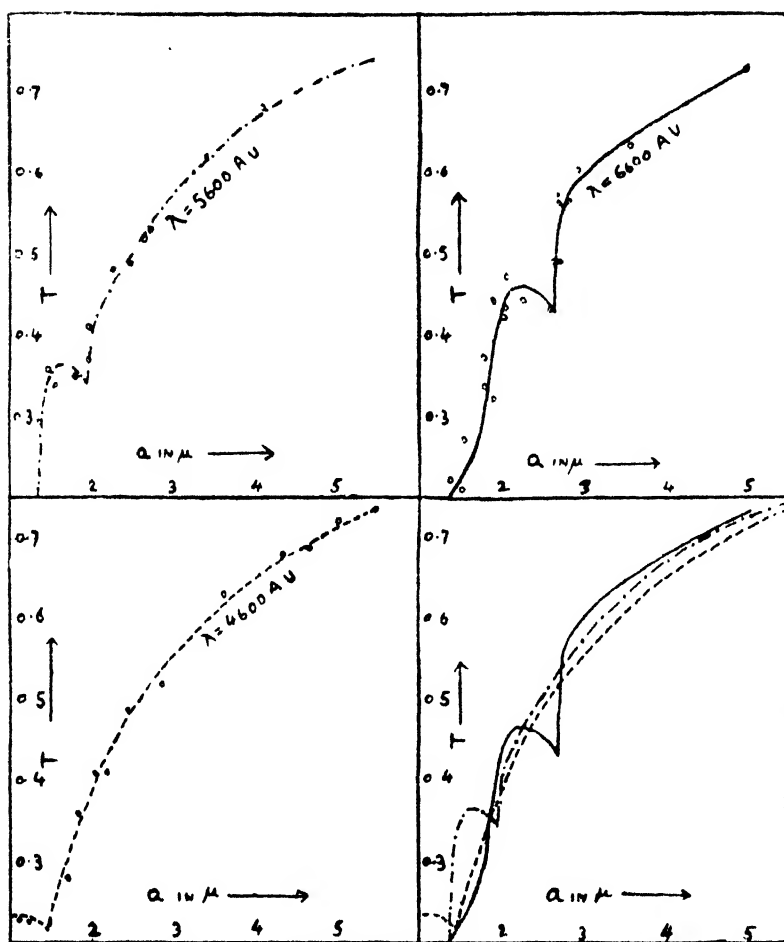


FIG. 11 KEROSENE

Table 12 gives the values of n_{am} .

Tables 13-14 represent verifications (1) and (2) respectively

TABLE 12

n	λn	n^{a_1}	n^{a_2}
1	6600	2.70	2.30
2	5600	1.95	1.65
3	4600	1.45	1.10 (?)

TABLE 13

λ	6600	5600	4600
$\frac{n^{a_2}}{n^{a_1}}$	0.85	0.85	0.76 (?)

Exp. value
for water:

0.86

TABLE 14

n	$\frac{n^{a_1}}{1^{a_1}}$	$\frac{n^{a_2}}{1^{a_2}}$	$\frac{\lambda n}{\lambda_1}$
2	0.72	0.72	0.85
3	0.54	0.48	0.70

The results do not satisfy verification (2); kerosene thus forms a partial exception to the theory. It is, however, to be noted that the experimental values show a remarkable agreement among themselves.

ALCOHOL.

Fig. 12 gives the transmission-curves for Alcohol.

This liquid is an exception to the general theory, the curves for different wave-lengths being practically identical.

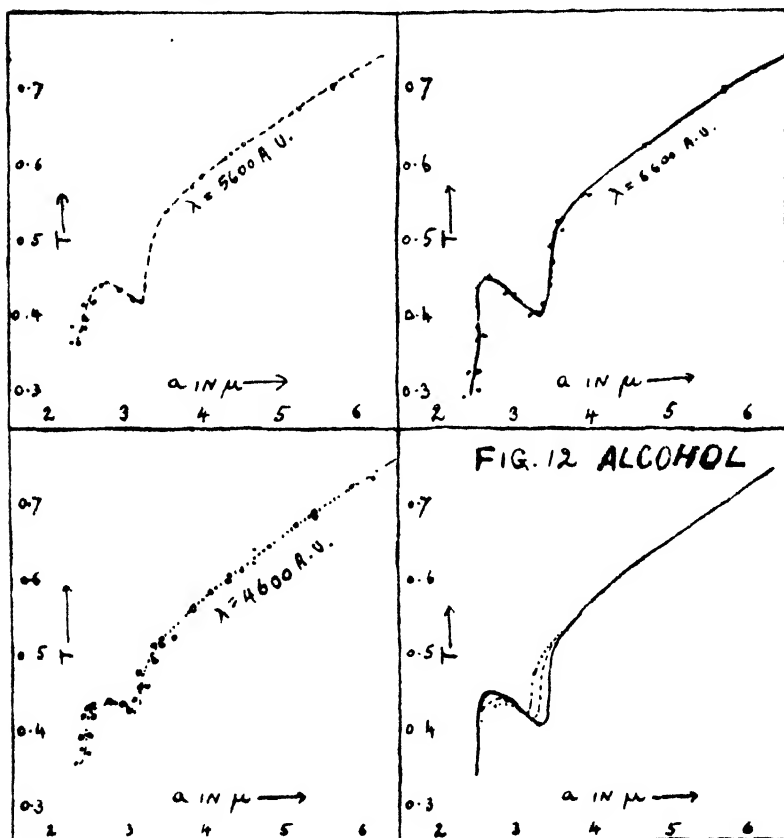


Table 15 gives the values of n_{am} .

TABLE 15

n	λn	n^{a_1}	n^{a_2}
1	6600	3.30	2.70
2	5600	3.15	2.80
3	4600	3.10	2.85

n^a_1 appears to increase very slightly with the wave-length while n^a_2 shows an opposite tendency.

TOLUENE.

Fig. 13 gives the transmission-curves for Toluene.

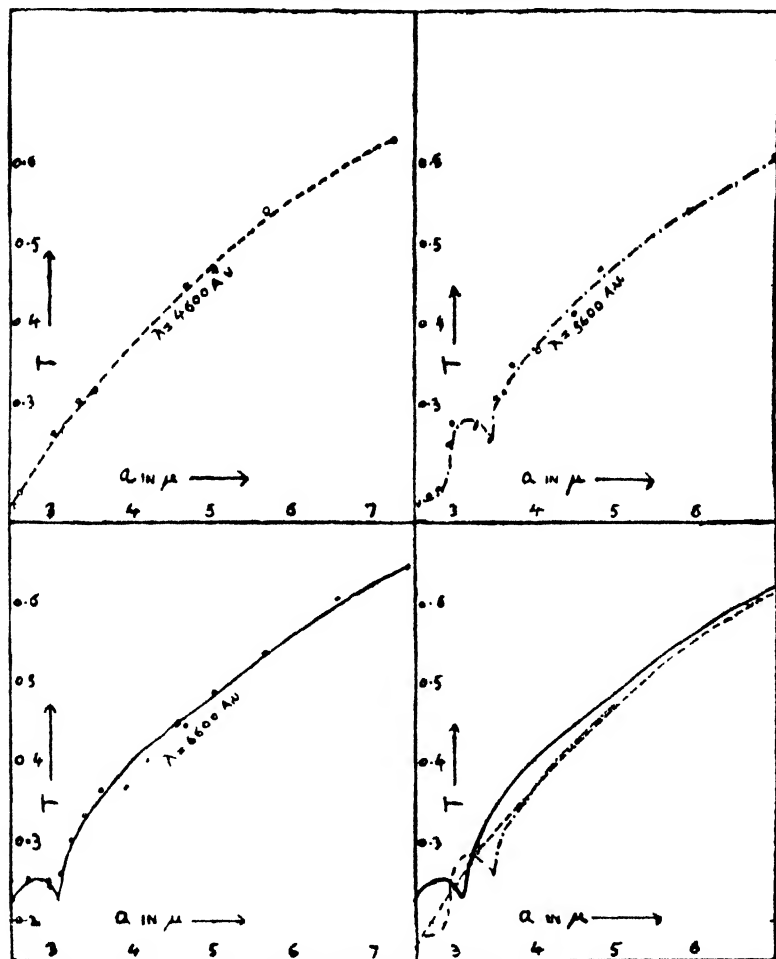


FIG. 13. TOLUENE.

This liquid is another exception to the general rule, the values of n_{am} increasing with decreasing wave-length, as table 16 clearly shows.

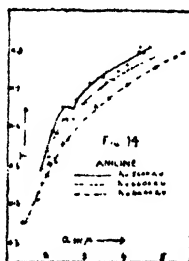
TABLE 16

n	λn	n^{a_1}	n^{a_2}
1	6600	3.10	2.90
2	5600	3.50	3.20

Large drops appear to transmit red light better than blue just as in the case of water.

ANILINE.

Fig. 14 gives the transmission-curves for Aniline.



Aniline is the third exception and stands out from other liquids on account of the absorption of light occurring in it. The curves are altogether different from those for the rest of the liquids. They show that blue light is more absorbed than the red while some intermediate colour is the least absorbed. The curves for $\lambda = 6600$ and 5600 A.U. show slight turning points (it is, however, uncertain whether any turning points exist here) while there is no trace of them in the curve for $\lambda = 4600$ A.U. There is one more point of interest in these curves; whereas in other liquids which are transparent the curves tend to approach one another for large values of a , no such tendency is exhibited here. This is perhaps on account of the absorption of the light by the drops. On the other hand the curves definitely show a tendency to meet when the drops are small, indicating that the absorption has become less.

GENERAL REMARKS.

The results in the case of CHCl_3 , CCl_4 , and Kerosene are very similar to those for water. These liquids have about the same refractive index, but their densities differ. A glance at Tables 6, 9, 12 for these liquids will show that the values of n^a_m for CCl_4 are only slightly smaller than those for CHCl_3 , while those for Kerosene are much smaller. This may be due to the small density of Kerosene.

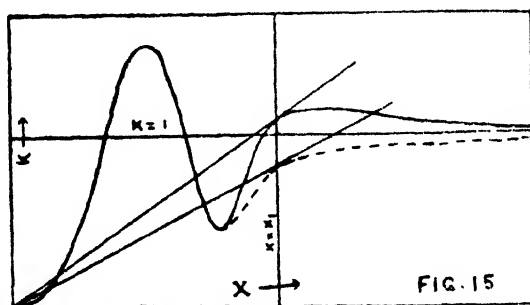
The curves for different wave-lengths are closer together and meet at a smaller value of a in the case of lighter liquids (cf. figs. 9-13).

No definite conclusions can be drawn about the effect of refractive index on the transmission.

Chloroform and Carbon Tetrachloride appear to be in agreement with the theory; Kerosene forms a partial exception; while Alcohol, Toluene, and Aniline show no agreement whatever. This is not surprising. Taking into consideration the limitations of the theory it would appear that agreement with the theory should really form the exception.

On the nature of the K-curve.

It was found in the case of water that red light was transmitted better than blue by large drops. This is at variance with the theory. With the exception of alcohol and aniline, in all other liquids investigated here the same result was obtained, viz., that red light was transmitted better than blue by large drops. It thus appears that the K-curves for these liquids should have similar nature for large values of x and that they should tend asymptotically to $K=1-0$ i.e. from below, as indicated by the broken line in fig. 15 and not to $K=1+0$ i.e. from above, as shown by the full line. The figure shows how this asymptotic approach from below can be in conformity with the other results obtained from the theory: The points of contact of the tangents from the origin to the two curves (broken and full) have the same abscissa.



SUMMARY.

The present work was undertaken to verify Stratton and Hough ton's theory of the transmission of light through clouds of water.

The paper gives a method of analysis for the verification of the above theory and describes suitable experimental arrangements for obtaining the necessary data.

The results obtained with water are discussed in detail and are found to agree tolerably well with the theory, with all its limitations.

IRON ARC SPECTRUM IN THE INFRA-RED.

By

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Until some years ago, few serious attempts were made to investigate the region of the spectrum beyond $0.8\ \mu$. Photographic plates sensitive to region upto about 11500 Å. have been made available on a commercial scale only very recently, and this has facilitated much of the spectroscopic work in this region. However one great disadvantage under which such work suffers in this country, is the rapid deterioration of the infra-red plates due to high temperature, unless special care is taken to store the material in a constant temperature cold chamber.

The present work arose as a result of infra-red equipment that has been made specially available to us very recently. With a view to obtain further knowledge of some of the diatomic molecules, in this less investigated region, we undertook some preliminary investigations on the technique, such as the photography and the wavelength standards. For all spectroscopic work in the visible as well as in the ultraviolet, the International Astronomical Union has fixed iron wavelength standards. No such standards have been officially adopted yet for the infra-red, though for practical purposes, the mapping of spectra in this region is mostly done by referring to argon and neon or the solar and atmospheric lines where available. The International Astronomical Union in their Report¹ of 1928, have suggested further measurement of the iron arc lines especially in the region λ 8327 and λ 8824. In the summary of the recommendations made, further search for suitable lines as standard in the infra-red has been advocated.

Considerable data has accumulated since the publication of the I. A. U.'s Report¹. Important among these are the results of Babcock², Meggers and Kiess³, Dingle⁴ and recently of Meggers⁵. Kayser and Konen⁶ have compiled a list of iron lines observed by different authors. Except the very recent work of Meggers,⁵ which is considered to be thorough and exhaustive, the data cannot be said to be conclusive unless large confirmatory material is available. It is also known that the sensitivity of the photographic emulsions varies with different makes and is generally supposed to fall with time

after sensitizing with ammonia. On account of this, the results of different authors may not agree with regard to the numerousness of lines, though the accuracy of readings can be guaranteed according to instruments used. The object of this paper is not so much to improve upon the accuracy as to give a catalogue of lines recorded on our plates in comparison to data already existing.

EXPERIMENTAL.

The iron arc was run on 230 volts at a current of 3 amps in air at 1 atmosphere. The rods used were of commercial type. The spectrum was photographed on the Hilger E_{305} spectrograph available for a range from 4000 Å. to 15000 Å. The dispersion on this, for higher wavelengths was considerably smaller than for the visible region. The spectrum from 8000 Å. to 9000 Å. covered about 8.2 mms on the plate and that from 9000 to 10000 Å. about 7 mms. The plates used were the Kodak III Q and III-L types. The mercury arc spectrum photographed on the former could give the 11287 line with ease even without further sensitizing. In order to reduce the time of exposure, we tried at first to photograph the infra-red region without filtering out visible radiations, but on experience it was found out that for the sake of fineness of lines, facility of measurement and accuracy of results in this low dispersion region, absolute clearness of background was necessary. This could not be attained unless the strong visible radiations, which cause general fogging are entirely cut out. The III-L type plate was very sensitive to region from 7000 Å. to 9000 Å. after sensitising with ammonia and with filter a few seconds being necessary to bring out this region on the plate. The advantage that we could gain in this short exposure was the reduction of slit-width to dimension consistent with the fineness of lines in the spectrum. These results are illustrated in plates I and II.

For spectrum beyond 9000 Å., the III-Q type plate was found much better after sensitizing. But these plates were found to deteriorate very quickly and even with cold chamber storage they showed a tendency to develop marks characteristic of old plates, though their life is somewhat increased by such storage.

No external comparison spectrum was taken to map the spectrum, but in any portion chosen for measurement, three suitable internal wavelengths of prominent iron lines were selected, and the intermediate wavelengths were then interpolated in the usual way. These prominent lines were selected from wavelength chart of Hilger and from a recent paper of Zaki Uddin⁷ giving compilation of revised prominent lines. Hilger's L_1 Comparator was used for the purpose of measuring the plates.

RESULTS.

A catalogue of lines measured in the above manner is given in the table below. The first column gives our own measurements. For comparison, the corresponding values from Hilger's chart based upon Babcock², Querbach⁸, Meggers and Kiess³ are entered in column 2, and those of Dingle in column 3. It was unfortunate that we could not get to hand the paper of Meggers⁵ on the interferometric measurements for the purposes of comparison. The results of Dingle,⁴ being the measurements on 10 ft. grating, are supposed to be accurate and they contain a few more lines than those recorded in column 1 or 2.

Table giving the iron lines measured and comparative values.

AUTHORS	HILGER'S CHART.	DINGLE.
7937.18 (8)	7937.182	
7945.97 (6)	7945.889	
7998.95 (8)	7998.988	
8028.95 (2)	8028.352	
8046.40 (8)	8046.083	
8085.10 (6)	8085.219	
8148.80 (0)	8149.590 M. K.	
8199.45 (1)	8198.980	
8207.60 (0)	8207.792	
8220.60 (8)	8220.422	
8232.20 (0)	8232.371	
8247.50 (?)	8248.190	
8293.70 (0)	8293.559	
8326.95 (10)	8327.080	
8339.70 (½)	8339.447	
8365.60 (4) d	8365.667	
8387.60 (10) b	8387.785	
8424.30 (0)	8424.140 M. K.	
8439.65 (2)	8439.607	
8468.40 (8)	8468.427	
8497.60 (2)	8497.020	
8514.10 (8)	8514.086	
8526.90 (0)	8526.685	
8542.10 (4) Fe?		
8582.40 (3)	8582.299	
8611.60 (6)	8611.837	
8621.40 (0)	8621.550 M. K.	
8661.70 (10)	8661.920	
8674.55 (4)	8674.772	
8688.60 (10)	8688.640	
8710.00 (?)	8710.280 M. K.	
8757.30 (4)	8757.160	
8763.90 (3)	8764.02	
8793.50 (4)	8793.380	
8824.05 (10)	8824.180	
8838.66 (3)	8838.36	8838.46
8866.80 (8)	8866.92	8867.00
8919.60 (0)	8919.95	8920.10

AUTHORS	HILGER'S CHART.	DINGLE.
8944.90 (2)	8945.15	8945.21
8975.40 (2)	8975.36	8975.43
8999.60 (8)	8999.54	8999.56
9012.30 (½)	9012.10	9010.64 & 9012.17
9025.30 (½)	9024.47	9024.49
9063.10 (?)	9062.29 M. K.	
9089.65 (6)	9089.40	9089.43
9118.90 (2)	9118.87	9118.92
9147.60 (0) d	9147.91	9148.08
9210.80 (½) d. b.	9209.99 M. K.	9210.05
9258.20 (1)	9258.4 & 9259.05	9258.38
9316.80 (0) ?	9318.09 M. K.	9318.25
9351.00 (½)	9350.52	9350.50
9360.90 (½)	9359.37 & 9362.36	9359.40 & 9362.40
9372.50 (½) d	9372.84	9372.92
9401.40 (½) d	9401.09	9401.18
9413.90 (1)	9414.14	9414.13
9442.60 (½) v. d	9443.98	9443.98
9453.30 (1)	9454.24	9452.56 & 9454.35
9512.60 (1)	9513.21	9513.26
9529.10 (½)	9529.31	9529.27
9569.60 (3)	9569.95	9570.02
9603.40 (½) b ?		
9628.00 (4) b., vd	9626.60	9626.60
9654.50 (4)	9653.18	9653.20 & 9657.32
9698.90 (½)	9699.70	9699.70
9738.90 (10)	9738.73	9738.64
9763.63 (4)	9763.34 & 9763.91	9763.63
9800.90 (3)	9800.42	9800.38
9862.50 (4)	9861.83	9861.85
9887.80 (4) v. d.	9889.11	9889.10
10064.7 (4)	10065.09	10065.08
10146.2 (4)	10145.64	10145.69
10216.5 (4)	10216.42	10216.44

b=broad, d=diffuse, v. d.=very diffuse M. K.=Meggers & Kiess.

It can be seen from the above table that many of the intense lines agree fairly well with those of the other authors. But on account of small dispersion of spectrograph used they cannot be said to be accurate to less than tenth of an Angstrom unit. In the case of very weak or diffuse lines, the error can be as high as one Angstrom unit or more. Except for some unresolved lines, the number noted is almost the same. Errors due to non-resolution or diffuseness are to be noticed in the lines especially 9360.9, 9453.3, 9654.5, 9442.60, 9628.00 and 9887.8 in the list. The line 8542.1 which appears with appreciable intensity in our photograph has not been found in Kayser & Konen's⁶ or H. Kayser's⁹ compiled lists as due to iron. We can neither identify it with any probable impurity in the sample of iron used. It may be noted that the line at 9063.10

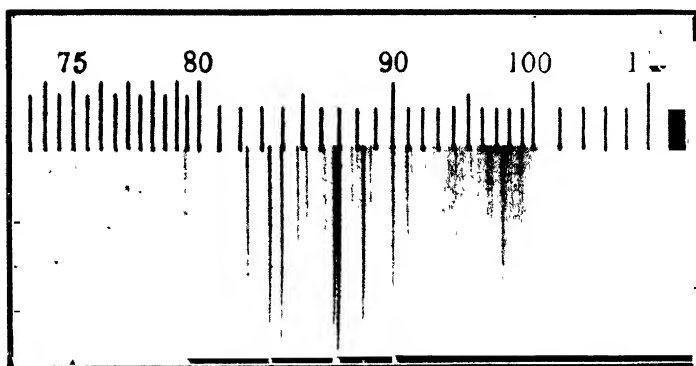


PLATE I.

Transaction 5: Iron Arc Spectrum in the Infra-red by Messrs. N. R. Tawde and V. S. Patankar.

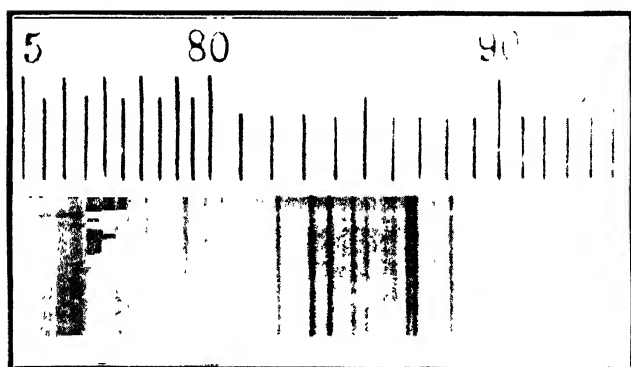


PLATE II.

Transaction 5: Iron Arc Spectrum in the Infra-red by Messrs. N. R. Tawde and V. S. Patankar.

which has been recorded on our photographs, can be identified in the list of Meggers and Kiess³, but cannot be confirmed from Dingle's⁴ recent results.

Summary: Infra-red spectrum of iron arc in air has been photographed on Hilger E 305 glass prism spectrograph and about 66 lines have been measured in the region from 7937 Å. to 10216 Å. The values have been compared to those of earlier investigators.

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- (5) Meggers, Bur. Stand. Jour. Res. 14, 33-40, 1935.
- (6) Kayser & Konen, Handbuch der Spectroscopie, Bd. VII.
- (7) Zaki Uddin, Current Science, 12, 620, 1935.
- (8) Querbach, Zeit. f. Physik., 60, 109, 1930.
- (9) H. Kayser. Taballe d. Haupt. d. Linienspektra. 1926.

THE TRACKS OF SWIFT NUCLEI IN PHOTOGRAPHIC EMULSIONS

By

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The following is a brief account of an investigation commenced recently in the Cavendish Laboratory, Cambridge, and now being continued in Wilson College, Bombay.

A number of methods have been devised during the past few years for recording fast nuclei. In particular, the Geiger Counter and the Wilson Expansion Chamber have been developed to an astonishing degree of perfection and the latter in particular has become an important tool of research. The method to be discussed provides yet another way of recording the tracks of swift nuclei, which has shown itself to have certain important applications. [Taylor: *Roy. Soc. Proc. A*, Vol. 150, p. 382, June 1st, 1935.]

It has been known for about 25 years that an α -particle, in its passage through the emulsion of a photographic plate, causes the silver bromide grains which it encounters to become developable. After development, the track of each particle is therefore marked out by a row of developed silver grains, and if these are sufficiently small and numerous they define the track of the particle with fair precision. As the range of the particles in the emulsion is less than one thousandth of that in air, the tracks can only be seen under a high magnification.

Ordinary commercial emulsions are not very suitable, though with special treatment of the plates good results have been obtained in certain cases by Fr. Blau and her co-workers in Vienna. For the present experiments, however, new emulsions have been devised (by the kind co operation of the Ilford photographic company), and these are specially suitable for the recording of particles. The accompanying photographs give an idea of the kind of results which are obtained.

α -particles

Various methods have been used for the recording of α particles. The plate may simply be soaked in a radioactive solution and then dried. The radioactive atoms are then actually in the gelatine, and

tracks are obtained distributed at random all over the plate. The number of tracks obtained depends, of course, on the time during which the plates are allowed to stand before development. Occasionally the radioactive solute forms minute crystals in the gelatine, which act as centres from which numerous α -particles are emitted. Thus one obtains a 'star' of tracks radiating from a centre, of which an example is reproduced in Fig. 1. In this case the plate had been soaked in a very weak solution of Th. (B + C).

For studying the individual tracks, it is more convenient to allow the particles to fall very obliquely on the surface of the emulsion, from a small source a few centimetres away from the plate. The experiment is done in a vacuum, so that the α -particles may reach the plate with their full energy. In this way one obtains well defined separate tracks.

It is found also that the glass of the photographic plates contains minute inclusions of radioactive substances. If these are near the surface, the particles emitted may pass out of the glass into the emulsion. An interesting example of this is shown in Fig. 2, where four tracks are seen to radiate from a point. At this point there has been a small radioactive inclusion, and the distance from this centre to the initial point of each track represents the distance which the α -particle has traversed in the glass, before rising into the emulsion.

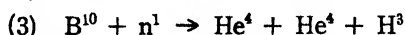
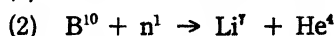
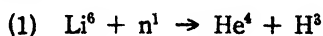
Recoil protons

When neutrons pass through the emulsion they leave no track of their own. Occasionally, however, they will come into collision with a Hydrogen nucleus, and the latter is knocked forward as a fast proton. Plates which have been exposed for some time to neutrons are found to show many such proton tracks, of maximum length corresponding to the energy of the neutrons employed. In the present experiments the maximum length found was nearly half a millimetre, corresponding to a range of some 60 cm. in air. Frl. Blau, who has investigated these protons for some time, has found even longer tracks. Fig. 3 shows a photograph of a recoil proton track in one of her plates, which she kindly sent for comparison. It will be seen that for these long tracks the large-grain process emulsion has advantages, in that the track is very clear and definite. A further point of interest is that this track shows a large angle deflection, caused by the passage of the proton near to a nucleus.

Disintegration tracks

It has further been found possible to record the tracks resulting from the disintegration of nuclei under neutron bombardment.

Lithium and Boron have been the elements studied so far. A suitable chemical compound is selected, and this is soaked into the emulsion, so that the latter is impregnated with atoms of the element in question. The plate is then exposed for a suitable time to neutrons. Occasionally a neutron makes a collision with a nucleus of Boron or Lithium, when it is found to cause a disintegration according to one of the following schemes: [Taylor and Goldhaber: *Nature*, Vol. 135, p. 341, March 2, 1935. Taylor: *Phys. Soc. Proc.*, Vol. 47, p. 873, 1935.]



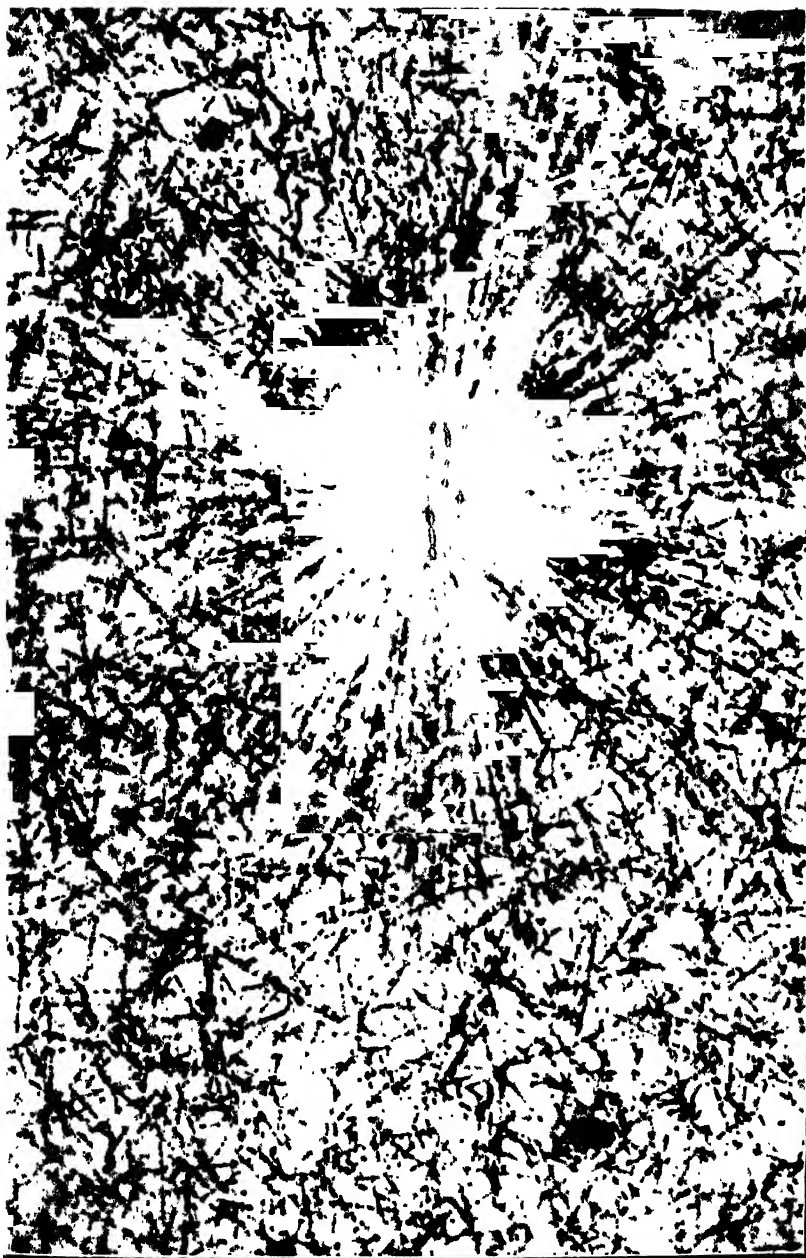
The energy appearing in the process depends upon the difference of mass between the two sides of the equation. In the case of reaction (3) the total mass of the three particles resulting from the disintegration is a little greater than the combined mass of the Boron nucleus and the neutron. Thus the reaction does not take place unless the neutron carries sufficient energy to make up for this difference of mass. Reactions (1) and (2), however, are exothermic, the sum of the masses on the right hand side of the equation being less than that on the left hand side. The difference is supplied to the resultant particles in the form of kinetic energy. Unless the bombarding neutron has large momentum, the total momentum after impact is small. Thus the two particles move away in nearly opposite directions, so that the two tracks appear as a single track.

Conclusion

The photographic method cannot be applied over such a wide field of investigation as, for example, the expansion chamber; but where applicable it has great sensitivity. In the expansion chamber the effective time of exposure is limited to a small fraction of a second, whereas the plates may be exposed to neutrons or other radiation for weeks or months. Owing to the high stopping power of the emulsion as compared with air, the equivalent volume in which tracks are obtained is many thousands of times greater than that of an ordinary chamber. Thus even extremely rare events (such as the occurrence of reaction (3)) may be recorded. These advantages make the method a powerful one, and it is now being applied to a variety of problems.

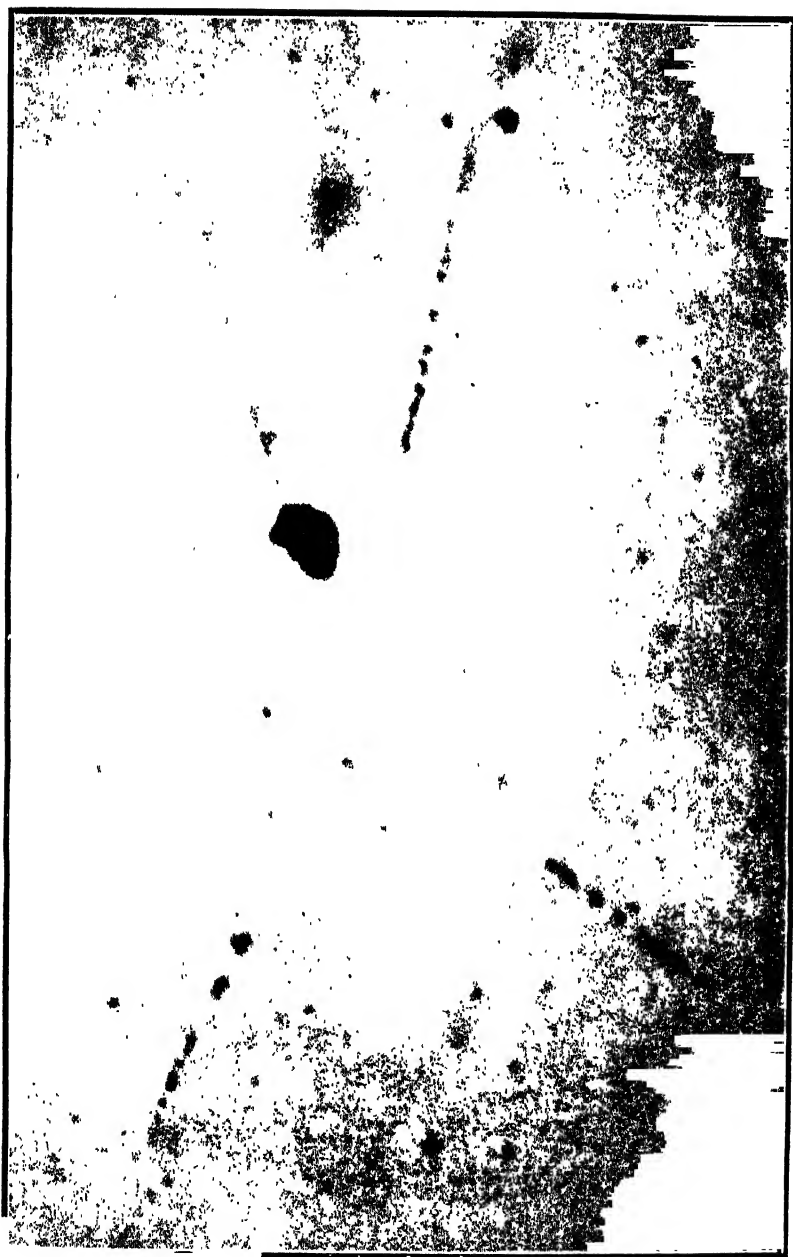
Description of photographs

Fig. 1 Numerous α -particle tracks produced by soaking the plate in a weak solution of Th. (B + C). Magnification 850 \times .



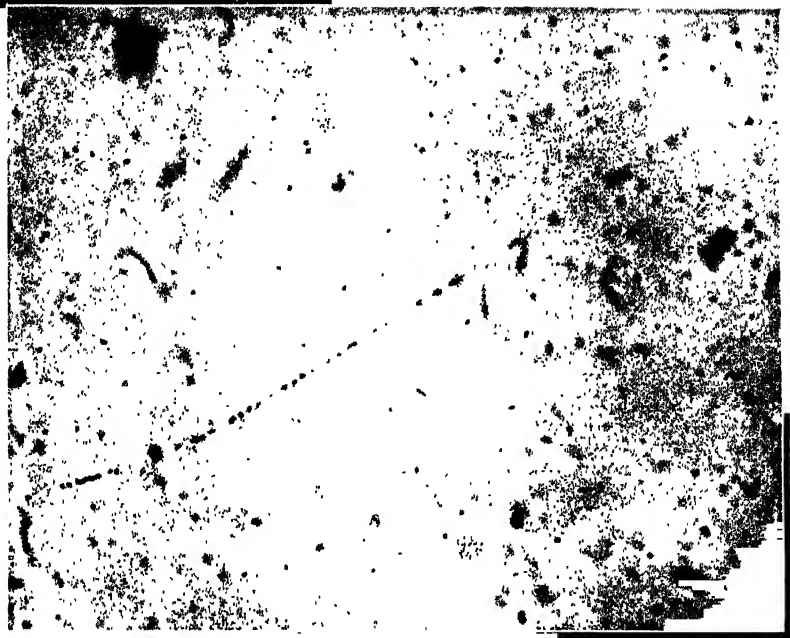
(Figure 1)

Trans. 6: The Tracks of Swift Nuclei in Photographic Emulsions : by Prof. H. J. Taylor



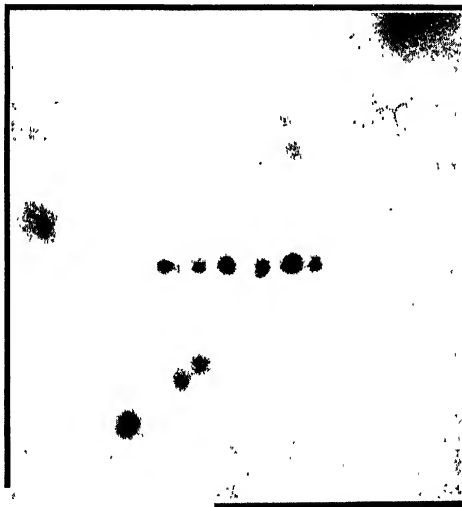
(Figure 2)

Trans. 6 The Tracks of Swift Nuclei in Photographic Emulsions by Prof. H. J. Taylor.



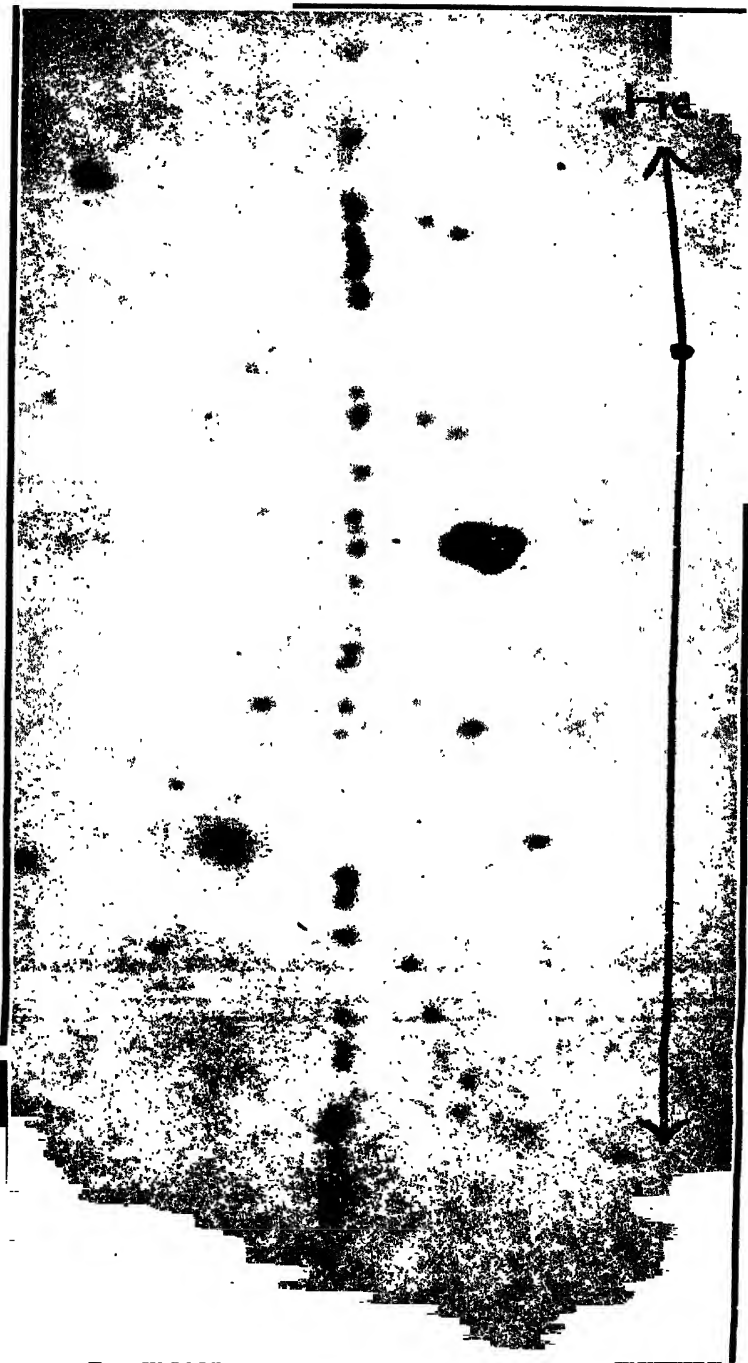
(Figure 3)

Trans. 6: The Tracks of Swift Nuclei in Photographic Emulsions* by Prof. H. J. Taylor



(Figure 4)

Trans. 6: The Tracks of Swift Nuclei in
Photographic Emulsions: by Prof. H. J. Taylor.



(Figure 5)
Trans. 6: The Tracks of Swift Nuclei in Photographic
Emulsions : by Prof. H. J. Taylor.

Fig. 2 Four α -particle tracks in the emulsion, arising from a radioactive inclusion in the glass. Magnification $2400\times$.

Fig. 3 Track of a proton produced by the passage of a neutron through the emulsion (Process plate). Magnification $600\times$.

Fig. 4 Typical track corresponding to reaction (2). Magnification $3000\times$.

Fig. 5 Tracks corresponding to reaction (1) The separate tracks of the two particles are indicated. Magnification $3500\times$.

ON THE NATURE OF CHEMICAL BINDING OF CERTAIN OXIDES AND SULPHIDES.

By

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I

In recent years there seems to be a good deal of difference of opinion regarding the nature of binding in compounds like the hydrogen halides and some oxides and sulphides, but in most cases proper data which will decide whether a compound is distinctly ionic or atomic are lacking. The present paper is in the nature of a discussion which attempts at proving that the bindings of the compounds ZnS, ZnO, CdS, CdO, HgS, CaO, SrO and BaO, investigated by the author are definitely ionic in nature.

In the case of diatomic compounds, specially the saturated oxides in which the atoms are divalent, some authors assign a structure on the same lines as that assigned to BeO by Mulliken¹. The emission band spectrum of BeO was found to be due to a transition $^1\Sigma \rightarrow ^1\Sigma$. Mulliken postulated that the ground state dissociates in the limit to Be ($s^2\ ^1S$) and O ($p^4\ ^1D$) when the distance between the nuclei is increased to infinity due to vibration energy.

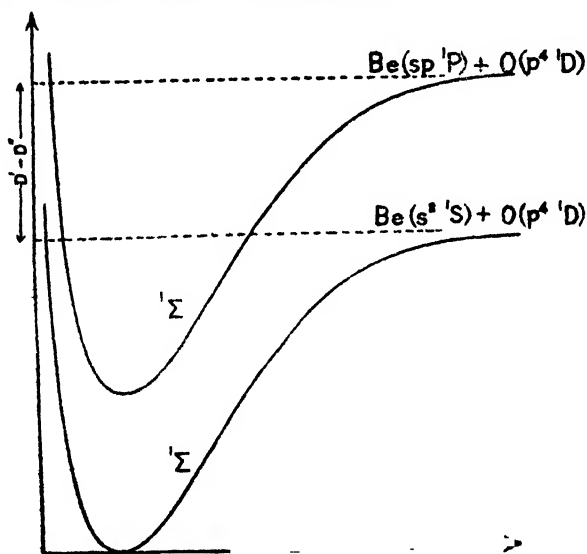


FIG. 1

Transaction No. 7: on the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

1. Mulliken, Rev. Mod. Phys. Part III.

We will disregard for the time being the suggestion by Herzberg¹ and others that the chemical linkages formed by the s^2 electrons are unstable.

The state $^1\Sigma$ which results from the foregoing association of BeO explains the diamagnetism of BeO. The excited state which is also a $^1\Sigma$ state dissociates into Be ($sp\ ^1P$) and O ($p^4\ ^1D$), that is, in the process of excitation Be (1S) has been raised to the state Be (1P). The Difference $D' - D''$ between the dissociation continua is claimed to be close to the value of $^1S - ^1P$ of Be, and the closeness is cited by the authors to prove the correctness of their hypothesis. But actually the agreement was not found to be so good as expected, and Lessheim and Samuel² were led to take an altogether different view of the structure of BeO in its ground and excited states. According to these authors, the picture is more like that shown in Fig. 2. They hold that even in the ground state one of the $2s$ electrons in Be is promoted to $2p$, and in the excited state both of them are promoted to $2p$. The value of $D' - D''$ is in better agreement with the energy of promotion $2s2p - 2p$ now.

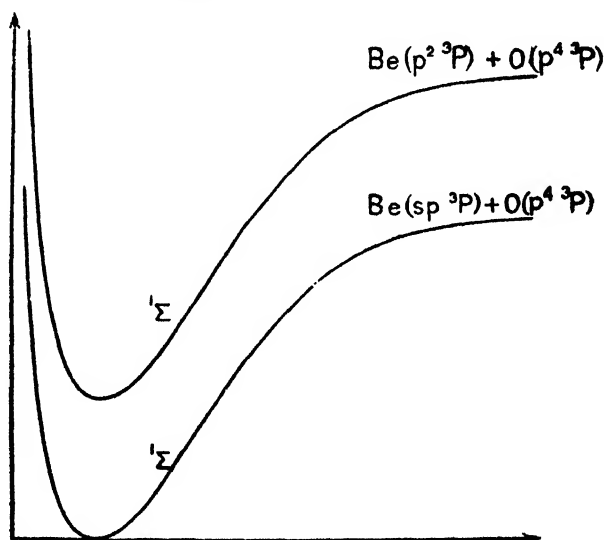


FIG. 2.

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

The application of the foregoing ideas to the sulphides³ and

1. Herzberg, Zeit. f. Phys. Vol. 75. p. 601, 1930
2. Lessheim and Samuel, Zeit. f. Phys. Vol. 84, p. 637, 1933.
3. Sen-Gupta, Proc. Roy. Soc. A., Vol. 143, p. 438, 1934.

oxides¹ of Zn, Cd and Hg receives a check at the very outset. The absorption spectra of the vapours of these substances were studied by the present author, and are reported elsewhere, but no trace of any band absorption was found between λ 8000 and λ 1900. If the theories of Lessheim and Samuel (*loc. cit.*) or of Mulliken (*loc. cit.*) held good the Franck-Condon diagrams of these compounds would be of the type given in Figs. 1 or 2, in which the atoms Be and O can be replaced by, say, Cd and S respectively. On account of the definite absence of band absorption at the expected place, it is clear that neither of the two associations of Cd and S, shown in Figs. 1 or 2 are involved in the ground state.

In all the oxides and sulphides investigated by the present author, not only are the band absorptions absent, but we have to account also for the continuous absorptions obtained. I have found that the vapours of these substances always show a continuous absorption beginning from a long wavelength limit ($h\nu_1$) followed by retransmitted patch of light with second absorption (beginning represented by $h\nu_2$). In the case of HgS, there is a third region of absorption ($h\nu_3$) after another retransmitted patch of light. These different absorptions can always be found, if the calculated limits are within the region of investigation. To account for the continuous absorption on the line of Mulliken's or Lessheim and Samuel's hypothesis, if we suppose, that the binding is of Hund's type a, the molecular states possible out of the combination Be ($s^2\ ^1S$) + O ($P^4\ ^1D$) are $^1\Sigma$, $^1\Pi$, $^1\Delta$ of which the $^1\Sigma$ state is presumably stable. The $^1\Pi$ and $^1\Delta$ states are most likely unstable since no emission band system due to them are known. We will consider here only the transition to the $^1\Pi$ state as the transition to the $^1\Delta$ state is forbidden by the selection principles. A Frank-Condon picture of the repulsive states is shown in Fig. 3. The excited state which is formed out of Be ($sp\ ^1P$) O ($p^4\ ^1D$) has a similar repulsive state $^1\Pi$. Absorption experiments if the picture were true, will reveal continuous absorptions due to



(while $^1\Sigma \rightarrow ^1\Sigma$ should show band absorption). The difference in energies of the first two long wave beginnings of absorptions, that is, $h\nu_1 - h\nu_2$ should then give the value of $^1S - ^1P$ of Be. But it is very difficult to try this experiment with BeO which melts at a very high temperature, and probably gives appreciable vapour pressure at a temperature higher than 2000° C. We have to fall back upon the compounds of Zinc, Cadmium, and Mercury mentioned above which were actually tried by myself.

If we suppose that the compounds investigated by me are built

1. Sen-Gupta, Bull. Acad. Sci. U. P. Vol 2, p. 245, 1933.

on a similar model, the continuous absorptions should be due to transitions from A to B and C (Fig. 3). The interval between the

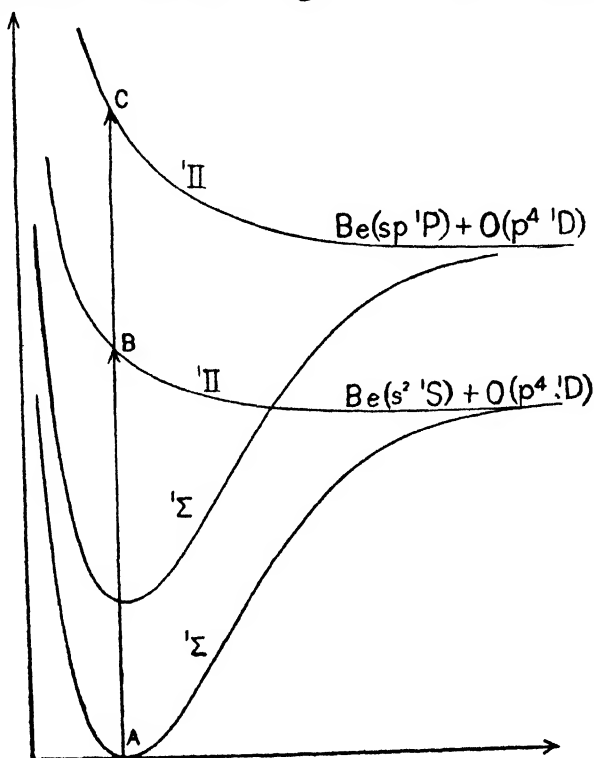


FIG. 3.

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

two cuts should equal $s^2\ ^1S - sp\ ^1P$ of Zn, Cd or Hg. But this is far from being the case as shown in the following table.

TABLE I

Substance	$h\nu_1 - h\nu_2$	$^1S - ^1P$ of metal
ZnS	1.3 volts	5.9 volts
CdS	1.3 volts	5.4 volts
HgS	1.22 volts	5.0 volts

Hence the Mulliken picture fails for the observed absorption spectra of the sulphides as well as oxides of Zn, Cd and Hg.

According to Lessheim and Samuel the linkage with the s^2 electrons of Be (or Zn, Cd and Hg) will give repulsive states only, so that the continuous absorptions may be said to be due to a transition to the repulsive states of the molecules formed by linkages with the s^2 electrons of the metal, as shown in Fig. 4. The ground state is

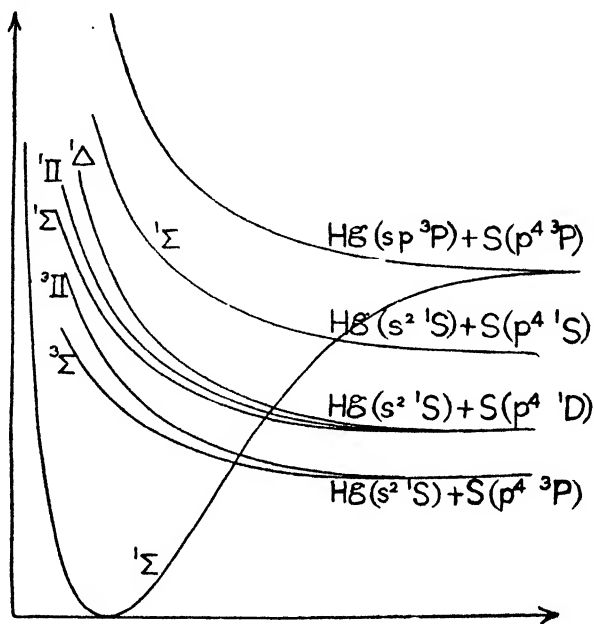


FIG.(4)

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

the same as in Fig. 2. The relative positions of the dissociation continua cannot be fixed with respect to the dissociation continuum of the ground state, the position of which is unknown if the linkage is supposed to be atomic. If there were only one repulsive state due to each metastable state of oxygen or sulphur atom, the three absorptions obtained by myself and their relative differences would be qualitatively explained. But there are in all six repulsive states, transitions to five of which are allowed. And again these should be intermingled with the repulsive states arising out of the combination of the ground state also, so that there would be more than five continuous absorptions mixed up with each other within the region investigated in some cases. The whole idea is too qualitative, and does not possess the simplicity and clearness of the assumption of an ionic binding with the units like Zn^{++} , S^{--} , as shown by the

present author in the papers on the oxides¹ and sulphides of the metals (loc. cit.).

II

In the case of CaO, SrO and BaO calculations showed that only the first absorption beginning was within the quartz region and the second fell in the fluorite region.

Mahanti² and others have investigated the emission band spectra of these compounds and have assigned the bands to the transition $^1\Sigma \rightarrow ^1\Sigma$. Mahanti assumes a picture of BaO similar to that of BeO of Mulliken, that is, in the ground state BaO has the constitution $\text{Ba}(^1\text{S}) + \text{O}(^1\text{D})$ and in the excited state $\text{Ba}(^1\text{P}) + \text{O}(^1\text{D})$. The following points may be put forward against this picture.

1. The band absorption corresponding to the so-called fundamental emission bands are absent, which means, that the ground state is not involved in the production of the emission bands.

2. An unstable state (which can also be present) due to $\text{Ba}(^1\text{S}) + \text{O}(^1\text{D})$ will give continuous absorption, as discussed in Part I of this paper. Since this repulsive state ^1II will have the same dissociation energy as the ground state $^1\Sigma$, the beginning of absorption (continuous) corresponding to transition AB in Fig. 5 will have almost the same energy as the dissociation energy of the ground state, or may be higher.

In the following table the calculated values of Mahanti (loc. cit.) of D' and the experimental values of the beginnings of absorption³ that is, $h\nu$, have been compared.

Table II

Substance	$h\nu$	D'
CaO	6.0 volts	4.58 volts
SrO	4.8 volts	1.52 volts
BaO	5.9 volts	6.32 volts

There is no agreement at all. In the first two cases we may try to stress the agreement by supposing that the repulsive curve ^1II is not horizontal but rises very steeply,⁴ so that AB (Fig. 5) is almost

1. Sen-Gupta, Bull. Acad. Sci., U. P. Vol. 2, P. 245, 1933.

2. Mahanti, Phys. Rev., Vol. 42, p. 609, 1932.

Proc. Phys. Soc., Vol. 46, p. 51, 1933

3. Sen-Gupta, Bull. Acad. Sci., U. P., Vol. 3, p. 203, 1934.

4. Sen-Gupta, Zeit. f. Phys., Vol. 88, 647, 1934.

double the value of D . But if this were the case, the absorption cut would not be sharp as actually observed in these cases, but would be very gradual as in the case of the hydrogen halides. So this argument fails.

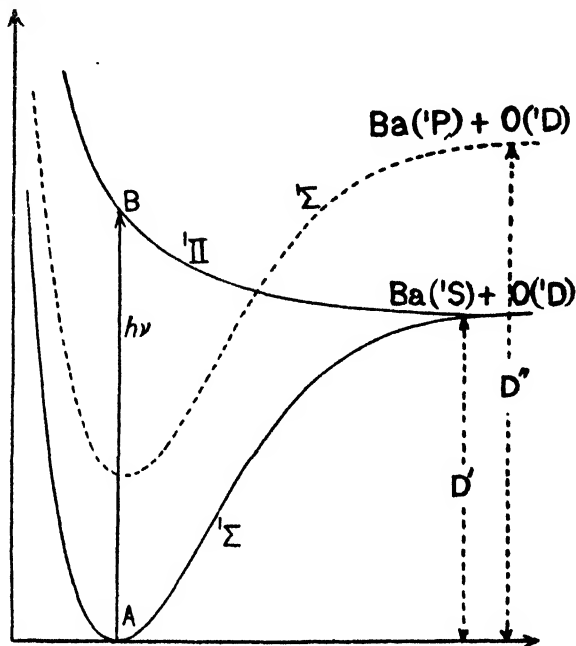


FIG. (5)

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

3. The differences of the dissociation energies. $D' - D''$ in Fig. 1 of two states of BaO which are responsible for the emission bands, are claimed to give the value of $^1S - ^1P$ of Ba by Mahanti, but it has been found that, $D' - D''$ agrees better with the value of $^2S - ^2D$ of Ba^+ . This shows that the emission bands are caused by two intermediate states, which are due to the ionic combination of Ba^+ and O^- , and Ba^+ (excited) and O^- respectively as shown in Fig. 6.

Since the dissociation energies are known it will be possible to ascertain, whether, the continuous absorption obtained by me is due to the transition to repulsive state which is caused by linkage with s^2 electrons of the metal. The ground state which is the stable state should then consist of $Ca(sp\ ^3P) + O(p^4\ ^3P)$ on the lines of Lesheim and Samuel (loc. cit.). There will be two repulsive states due to the combination $Ca(s^3\ ^1S) + O(p^4\ ^3P)$, that is, $^3\Sigma$, $^3\Pi$ having

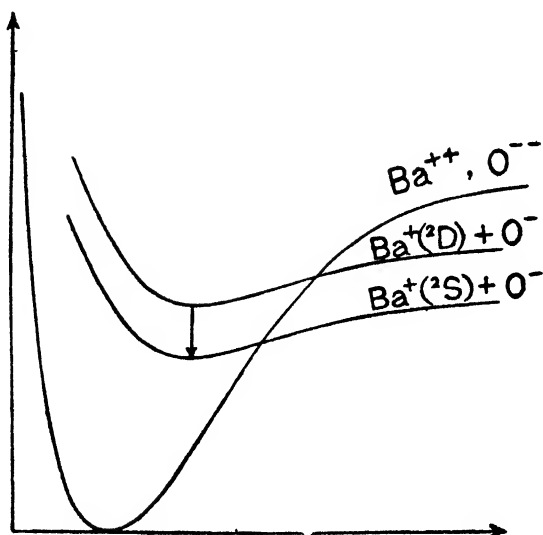


FIG. 6

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

common dissociation energy. The potential energy curves of the repulsive states will cut that of the ground state as shown in Fig. 7.

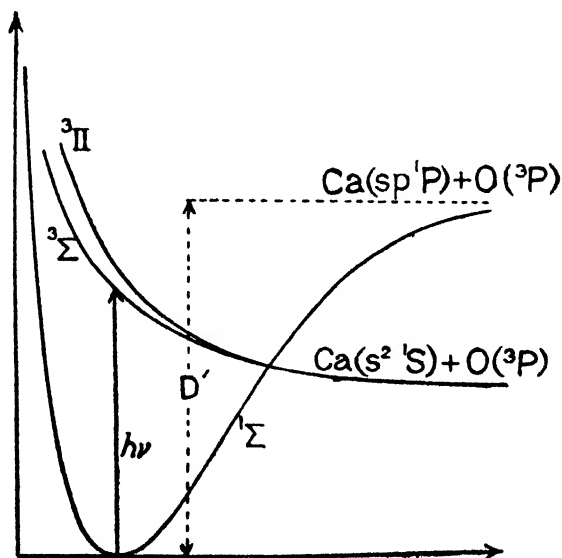


FIG. 7.

Transaction No. 7: On the Nature of Chemical Binding of certain Oxides and Sulphides by P. K. Sen-Gupta.

It is evident that the first beginning of absorption $h\nu_1$ will correspond to an energy which is less than the energy of dissociation D' of the ground state.

From Table II it is seen that in two of the cases, values of $h\nu$, instead of being smaller, are so much greater than those of D' as to make the idea agreement absurd. It has already been pointed out that on account of the sharp absorption cuts we cannot assign a steep inclination to the upper curves so as to give a better agreement between $h\nu$ and D' .

The logical conclusion from the foregoing arguments is that the assumption of an atomic binding for the saturated oxides and sulphides cannot explain the experimental results obtained by the author. On the other hand such an assumption leads to insuperable difficulties. The assumption of an ionic binding, on the other hand explains the results satisfactorily, as shown in the previous papers.

My best thanks are due to Prof. M. N. Saha, D. Sc., F. R. S., for his encouragement in connection with this work. I am also thankful to Dr. Lessheim and Dr. Samuel for some criticisms and discussions.

ON THE THEORY OF VISCOSITY OF LIQUID METALS.

By

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In view of the recent investigations into the properties of liquid metals, it may be of interest to study the phenomenon of the viscosity of metals in the liquid form from the point of view of the electron theory. Following the recent work of Andrade¹ and also of Mott² we take the liquid metal near the melting point as still possessing the lattice structure which was characteristic of it in the solid state—the Debye or rather Einstein characteristic frequency being, of course, different in the liquid state. In fact,

$$\left(\frac{\nu_L}{\nu_S} \right)^3 = -\frac{L}{e k T}$$

where L is the latent heat. The formula for the viscosity of liquids deduced by Andrade on the assumption of this continuity of lattice structure may be obtained as follows:—

If m is the mass of a molecule and l is the average distance between the centres of the molecules, the change in momentum in one period is $2 \ ml \ \frac{dv}{dz}$

or the change in momentum per second is $2 \ ml \ \frac{dv}{dz} \ \nu$

where ν is the frequency of vibration of the molecule. If we make the usual simplifying assumption that one-third of the molecules are vibrating along each of the three directions normal to one another, the change in momentum for all molecules in unit area will be :

$\frac{2}{3} N \ \nu \ ml \ \frac{dv}{dz}$ where N is the number of molecules per unit area of a layer and is equal to $\frac{1}{l^3}$

Supposing now that the communication of momentum takes place at every extreme libration and that a molecule conveying momentum crosses a plane parallel to the drift twice in every complete vibration, the transfer of momentum per second per unit area is

$$\frac{4}{3} N \ \nu \ ml \ \frac{dv}{dz} = \frac{4}{3} \frac{\nu m d}{l} \frac{dv}{dz} = \eta \frac{dv}{dz}$$

Hence

$$\eta = \frac{4}{3} \frac{\nu m}{l}$$

Substituting for ν from Lindemann's formula³,

$$\nu = C \sqrt{\frac{T_m}{A V_A^{2/3}}}$$

where ν is the fundamental frequency, T_m is the melting point, A , the atomic weight and V_A the volume of a gram-atom at temperature T_m , we get,

$$\eta = \frac{4}{3} \frac{m}{l} C \sqrt{\frac{T_m}{A V_A^{2/3}}}$$

Since

$$l = \left(\frac{V_A}{N}\right)^{1/3} \text{ and } m = \frac{A}{N}$$

where N is Avogadro's number, we obtain,

$$\eta = \frac{4}{3} C \frac{(A T_m)^{1/2}}{(N V_A)^{2/3}} = 5.1 \times 10^{-4} \frac{(A T_m)^{1/2}}{(V_A)^{2/3}} \dots (1)$$

for $C = 2.8 \times 10^{12}$ and $N = 6.06 \times 10^{23}$

This is Andrade's formula for the viscosity of liquids.

The Debye frequency ν in the relation $\eta = \frac{4}{3} \frac{\nu m}{l}$ may however

be expressed with advantage in terms of the Debye temperature θ_L as is more usual with workers in modern Physics and perhaps theoretically better than expressing it in terms of the melting point temperature T_m . In view of the imperfect knowledge of the behaviour of adjacent layers and molecules of liquids and of the average distance by which a molecule leaves its position of equilibrium it may also be safer to introduce a constant β in the relation between l and n and put $\beta l = n^{-1/3}$ where n is the number of molecules per unit volume. We then get,

$$\eta = \frac{4}{3} \beta \nu m n^{1/3}$$

If ρ denotes the density, A , the atomic weight and m_H the mass of the hydrogen atom, we have,

$$n = \frac{\rho}{A m_H} \text{ and } \eta = \frac{4}{3} \beta \nu \left(\frac{\rho}{A}\right)^{1/3} A m_H^{2/3}.$$

Putting

$$h \nu = k \theta_L \text{ or } \nu = \frac{k}{h} \theta_L$$

where k represents Boltzmann's constant, h is Planck's constant and θ_L is the Debye characteristic temperature, we have,

$$\eta = \frac{4}{3} \beta \frac{k}{h} m_H^{2/3} A \left(\frac{\rho}{A}\right)^{1/3} \theta_L \dots \dots \dots (2)$$

Both the formulae (1) and (2) express the viscosity in terms of experimental constants having nothing to do with viscosity measurements.

We can now compare the values of viscosity calculated from the above theoretical formulae (1) & (2) with the observed values of

viscosity of certain liquid metals for which published experimental data exist.

Table giving the calculated and observed values of viscosity of liquid metals.

Liquid metal	η cal. from (1)	η cal. from (2) with $\beta = 2.3$	η obs.
Cd	.....	0.024	>0.018
Hg	0.021	0.023	0.021
Cu	0.038	0.032	0.038
Sn	0.019	.....	0.020
Pb	0.025	0.023	0.028

It will be seen from the above table that the agreement between the values calculated from (2) and the observed values is fairly satisfactory considering the uncertainty⁴ about the experimental results obtained by different workers. The values calculated from (1) are, no doubt, in extraordinarily close agreement with the observed values but this seems to be more or less a chance coincidence. For, in view of the approximate nature of the assumptions and also the discrepancies in the values of viscosity obtained by various observers⁵, one cannot legitimately expect an agreement within 5 or 10 percent. The values obtained from formula (2) depend upon the value of the constant β which takes account of the crystal structure of the metal. Formula (2) has the additional advantage that it expresses the frequency ν in terms of the Debye characteristic temperature θ_L which is more in keeping with the modern tendency⁶ in theoretical physics and perhaps better than putting ν in terms of the melting point T_m .

The above theory applies rigorously to the viscosity of monatomic metals. The problem of diatomic molecules is therefore left untouched for the present.

REFERENCES :

- (1) cf. Andrade, Phil. mag., 1934, 17, 497
- (2) Mott, Proc. Roy. Soc., 1934, 146, 465
- (3) Lindemann, Phys. Zeitschr., 1911, 11, 609
- (4) Andrade, Phil. Mag. 1934, 17, foot-note on P. 508
- (5) Andrade, loc. cit.
- (6) Mott, loc. cit.

ON THE MAGNETIC MOMENT OF THE NUCLEUS AND
HYPERFINE STRUCTURES IN THE SPECTRUM OF
DOUBLY IONIZED ANTIMONY WITH A NOTE ON
THE STRUCTURE OF THE ARC LINE $\lambda 3723$.

BY

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Summary :

Hyperfine structures of two doublets of the spectrum SbIII have been studied and an approximate value for the magnetic moment of the nucleus derived. A discussion of this has led to a modification of the gross structure analysis. The structure of the arc-line $\lambda 3723$ has been interpreted taking the mechanical moment of the nucleus $= (5/2) h/2\pi$ for both isotopes.

Introductory :

It is now well known that many spectral lines which appear sharp when examined with spectroscopes of ordinary resolving power split up into a number of components when high resolving power is available. The fact that atoms of the same element have different atomic weights sometimes contributes for some reasons to this so-called hfs* of lines, the effect varying for individual spectral lines. But even simple atoms do show such structures. It was further found that these structures in the favourable cases showed a multiplet form similar to the ordinary multiplets of the gross structures but in a miniature form and it was also found that Lande's interval rule was obeyed for this term splitting as well. Ruark and Chenault¹, in order to explain this, for the first time introduced one more quantum number F besides the already existing N, L, S and J. Pauli² assigned to the nucleus a favoured direction. With this was associated a definite magnetic moment and hence, just as in the case of the spinning electron, a definite mechanical moment $h/2\pi$, corresponding to a nuclear spin quantum number I. The magnetic moment interacts with the extra nuclear electrons. Thus the total angular quantum number J combines vectorially with I giving rise to the fine quantum number F. The original single energy level characterised by J splits up into $2J+1$ (or $2I+1$, if J is greater than I) levels characterised by definite F values. For the gross structure the mechanical moment

* hfs stands throughout for hyperfine structures.

for a particular state arising from a definite electronic configuration is given by J expressed in units $h/2\pi$ and the magnetic moment is given by $J.g$ expressed in terms of Bohr-magnetons, i. e. $eh/4\pi mc$ units m being the mass of the electron. Here, g is the well known Lande-factor which can be theoretically calculated and derived from the Zeeman effect data. The corresponding ratio of the magnetic moment of the nucleus, expressed in units $eh/4\pi Mc$ or proton-magnetons M being the mass of the proton, to its mechanical moment, expressed in units $h/2\pi$, is known as the $g(I)$ factor. This can be calculated from observed hfs with the aid of mathematical formulae derived by Goudsmit³.

Antimony has two isotopes of atomic weight 121 and 123, their abundance ratio being 100 : 78.5⁴. From a study of the hfs of the lines of the first spark spectrum by the author⁵ their nuclear spin-moments were found to be $5/2$ for Sb^{121} and $7/2$ for Sb^{123} . These were further utilised in explaining the structures of the arc lines⁶. Crawford and Bateson⁷ have corroborated the above values of the spin-moments from their observations of the hfs of the lines of the trebly-ionized atom. Later, however Tolansky⁸ studied the hfs of some lines of the first spark spectrum using a cooler source and concluded that $I = 5/2$ for Sb^{123} as well.

Experimental :

In the present investigation the source used was a quartz discharge-tube which could be evacuated by means of a mercury-pump and filled with helium at low pressure as desired. Metallic antimony was kept in the bulbs of the discharge-tube and heated. A sketch of the discharge-tube is given in Fig. 1. A condensed discharge was passed through the capillary portion of the tube, 4 cm. long and 1.5 mm. in diameter, and excited the SbIII lines quite strongly. For investigating the hfs a Fabry-Perot etalon was placed in the parallel beam of light between the collimator and the prisms of a Zeiss-constant-deviation three-prism glass spectrograph for which the average dispersion in the region investigated was 8.8 A. U. per mm. Invar rings of suitable thicknesses, inserted between the two quartz plates of the etalon, served to give the desired dispersion for the hfs.

The wave-lengths of the four lines selected for a study of their hfs are given below in column 1 of Table I and their classifications⁹ in column 2. The observed hfs were diffuse but each line was clearly resolved as a doublet, the component to the longer wave-length being the stronger of the two. The visually estimated intensities of the components are in the ratio of about 4 : 3. Separations of the two components for the respective lines are given in wave-numbers

to two places of decimals in column 3 of the Table, the separations being measured between points of maximum intensities of the components.

Photographs of the fringes of the four lines given in the Table are reproduced in plate I, A, B, C, D. A and B are taken with a gap of 2mm. between the etalon plates, while C and D are taken with a 3mm. gap corresponding to dispersions 2.5ν and 1.6ν respectively per order.

TABLE I.

λ I. A.	Classification.	Separation. $\Delta \nu$
4265.09	(5s. ² 6s.) $^2S_{\frac{1}{2}}$ - (5s. ² 6p.) $^2P_{\frac{3}{2}}$	1.27
4591.89	(") " - (") $^2P_{\frac{1}{2}}$	1.40
4352.16	(5s.5p.) " - (") $^2P_{\frac{3}{2}}$	0.45
4692.91	(") " - (") $^2P_{\frac{1}{2}}$	0.55

Discussion.—It is of course not possible to throw any further, light on the values of the nuclear spin moments from the available data. Theoretically we should expect $\lambda\lambda$ 4265 and 4352 to be split up into six components corresponding to each isotope i.e. either line should show twelve components. $\lambda\lambda$ 4592 and 4693 should similarly show eight components each. In Fig. 2 are given the very useful graphical pictures¹⁰ of what the components would look like for the transitions ... (a) $^2S_{\frac{1}{2}} - ^2P_{\frac{3}{2}}$ and (b) $^2S_{\frac{1}{2}} - ^2P_{\frac{1}{2}}$, for the isotope Sb¹²¹. The intersections of any horizontal line with the graph would give the relative positions of the components for a definite ratio of the splitting factors of the combining terms. At the centre, only the 2S splitting would be responsible for the structure, the splitting factor for the 2P term being zero i.e. corresponding to the ratio 1:0. The top and the bottom correspond to the ratios 1: + 1 and 1: - 1 respectively. The theoretically calculated relative intensities¹¹ of the components are given at the bottom. The thick lines give the mean positions of the unresolved components due to the 2P term-splitting. It is evident that a comparatively small splitting of the 2P terms would show the structures as doublets. Further, a similar but narrower structure would be superposed on this due to the second isotope, its I-value being taken equal to 5/2. It can be concluded

from the observed patterns that the $6s\ ^2S$ term has the largest splitting factor, next comes the $(5s\ 6p^2)\ ^2S$ term, while the $6p\ ^2P$ terms have small but positive factors that of $^2P_{\frac{3}{2}}$ being smaller of the two. Giving the $^2P_{\frac{3}{2}}$ term a small negative factor would lead us to assign a comparatively large value for the $^2P_{\frac{3}{2}}$ splitting which would not be compatible with the observed data. The resultant term splitting for the two isotopes would be about $1.38\ \nu$ and thus the splitting for the $6s\ ^2S$ term for the lighter isotope* would be about 1.58 , which gives for the splitting factor a value $A \approx 0.53\ \nu$ approximately. The corresponding factors for the $6p\ ^2P$ terms would be the order of $0.02\ \nu$.

For calculating the $g(I)$ factor from the splitting of a term, arising from a single outer s-electron, Goudsmit³ gives the following formula :

$$(I) = \left[\frac{3A \cdot n_o^3 \cdot 1838}{8R \alpha^2 Z_i \cdot Z_o^2 \cdot K(\frac{1}{2}, Z_i)} \right], \text{ where } K(J, Z_i) = 4J(J + \frac{1}{2})(J+1)(4J^2 - 1)\rho.$$

and $\rho^2 = (J + \frac{1}{2})^2 - (\alpha \cdot Z_i)^2$. Here, n_o is the effective total quantum number and could be calculated from a knowledge of the absolute term-value. For SbIII, Lang⁹ gives for the $6s^2S$ term a value 107321 , and for the $5s5p^2\ ^2S$ term 106852 , based on an arbitrary choice of $64000\ \text{cm}^{-1}$ for the $5f\ ^2F_{\frac{7}{2}}$ term. Corresponding to the term value $107321\ \text{cm}^{-1}$, $n_o = 3.034$, Z_o is the effective nuclear charge for a hydrogenic orbit, and in the case of a doubly-ionized atom, therefore, is equal to three. Z_i is the effective nuclear charge for a penetrating orbit and for an s-electron $Z_i = Z = 51$ for antimony. R is the Rydberg constant and α is the fine-structure constant $= 2\pi e^2/hc$. The $g(I)$ value on calculation comes out to be about 2.88 units and the corresponding magnetic moment is about 7.2 proton-magnetons for Sb^{121} . Goudsmit³ has calculated the magnetic moments from the author's hfs data for the SbII lines. He obtains the value 2.7 for Sb^{121} and 2.1 for Sb^{123} , corresponding to the $g(I)$ values 1.1 and 0.6 respectively. Breit and Wills¹² by a more detailed theoretical consideration obtain the value 1.3 instead of 1.1 . It is interesting to note that taking the ratio of the $g(I)$ factors of Sb^{121} and Sb^{123} as 1.37 , as given by Tolansky⁸, and the I -value as $5/2$ for both, corresponding to the value 2.7 for Sb^{121} the magnetic moment for Sb^{123} comes out to be 2.0 , not differing much from the value already quoted above. The value 7.2 , as here obtained, is no doubt not very exact; nevertheless, it shows that the formula

* Calculated from the known ratio of the abundance of the two isotopes and the ratio of their $g(I)$ factors.

applied to the hfs of the lines of the doubly-ionized atom gives rather too high a value.

The abnormal value obtained is in the author's opinion due to an improper classification of the gross structure of the SbIII spectrum. If the $6s\ ^2S$ term is interchanged with the $5s\ 5p^2\ ^2S$ term, the $g(I)$ value deduced is very near the value obtained by Goudsmit and the large splitting thus assigned to the $5s\ 5p^2\ ^2S$ term (as modified) is also not unexpected. In fact, in a previous classification Lang¹³ put the $6s\ ^2S$ term higher than the $5s5p^2\ ^2S$ term, but later, in order to bring the classification in consonance with that of As III, he put the higher term as $5s5p^2\ ^2S$ and the lower as $6s\ ^2S$ However, a comparison of the relative intensities of the two doublets supports the modification. The transition $s\ ^2S \leftarrow p\ ^2P$ should be more probable than the transition $s\ p^2\ ^2S \leftarrow p\ ^2P$ which involves a double electron-transition. The latter should therefore be expected to be weaker in intensity. Of the two doublets of the spectrum Sb III that to the longer waves is decidedly the stronger and should therefore involve the $s\ ^2S$ term which substantiates the above modification. For the spectrum As III on the other hand, the doublet to the shorter waves is the stronger and this is in accord with the existing classification. A study of the hfs of the corresponding lines of the spectrum As III has now been undertaken and would help to decide the question. Further, in support of this modification it may be noted that in the spectra $SeIV^{14}$ and $TeIV^{15}$, iso-electronic with AsIII and SbIII respectively, the $s\ ^2S$ term is higher than the $p^2\ ^2S$ term. In Table 2 are given the absolute term-values for GaI-like and InI-like spectra for the two terms in question, those for SbIII being modified as suggested above. The term-values for the first spark spectrum are divided by four, those for the second spark spectrum by nine and so on, for better comparison. As is seen from the Table, the change in the relative term-magnitudes of the $s\ ^2S$ and $p^2\ ^2S$ terms is quite gradual from the arc spectrum to that of the trebly-ionized atom.

TABLE 2.

Spectrum	Term-values		Spectrum	Term-values	
	$5s\ ^2S$	$4s4p^2\ ^2S$		$6s\ ^2S$	$5s5p^2\ ^2S$
Ga I	23592	8115	In I	22295	—
Ge II	16559	13586	Sn II	15204	8996
As III	13524	13400	Sb III	11872	11925
Se IV	11803	13582	Te IV	10727	12222

Taking the previously accepted $5s5p^2\ ^2S$ term, then, as the real $6s\ ^2S$ term, the resultant term-splitting for the two isotopes would be about $0.52\ \nu$. This gives for Sb^{121} , for the $6s\ ^2S$ term, a splitting about $0.60\ \nu$ corresponding to the splitting factor $A = 0.20$. Taking the absolute term-value = 106852, the effective quantum number $n_0 = 3.040$. Substituting these in the $g(I)$ formula we get $g(I) = 1.1$ approximately, rather in too good an agreement with the value given by Goudsmit. The corresponding magnetic moment for Sb^{121} would be 2.7 proton-magnetons.

Structure of $\lambda\ 3723$:

The structure of this particular arc-line $\lambda\ 3723$, ($5p^3\ ^2P_{\frac{3}{2}} - 5p^2\ 6s\ ^4P_{\frac{3}{2}}$), was explained in detail by the author in a previous publication.⁶ The separations of the observed positions of its six components in $10^{-3}\ \text{cm}^{-1}$ were given as follows: 0, (9); 98, (8); 250, (10); 470, (3); 615, (8); and 724, (9). The figures in brackets give the visually estimated intensities. Of these six components the middle two are blends. The structure was explained by taking the I -values $5/2$ and $7/2$ for Sb^{121} and Sb^{123} respectively. The structure could also be explained fairly satisfactorily taking $I=5/2$ for Sb^{123} as well, as given by Tolansky⁸, whose deduction is entitled to more weight on score of a better source. The ratio of the $g(I)$ factors could be calculated by taking the ratio of the separations between the first and the last and the second and the fifth components and comes out to be 1.4 , which is in very good agreement with 1.37 derived by Tolansky. The interval factors, expressed in $10^{-3}\ \text{cm}^{-1}$, for the $5p^3$ term are 162 and 116 and for the $5p^2\ 6s$ term 79 and 56 for Sb^{121} and Sb^{123} respectively. The observed positions of the two unresolved middle components are very near the calculated positions of their resultants. The structure calculated from the above interval factors is given below in Table 3. Figures enclosed in brackets give the calculated¹¹ relative intensities of the components.

TABLE 3.

Isotope	Calculated structure in unit $10^{-3}\ \text{cm}^{-1}$				Centre of gravity.
121	0 (70)	237 (56)	487 (20)	724 (70)	341
123	98 (56)	266 (45)	447 (16)	615 (56)	341

A comparison of the observed structure (a) with the calculated structure (b) is given in Fig. 3. The lengths of the lines represent the intensities.

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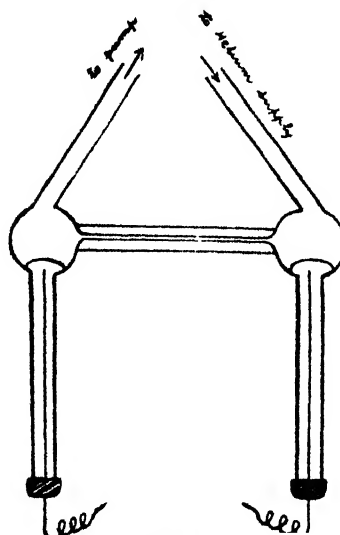
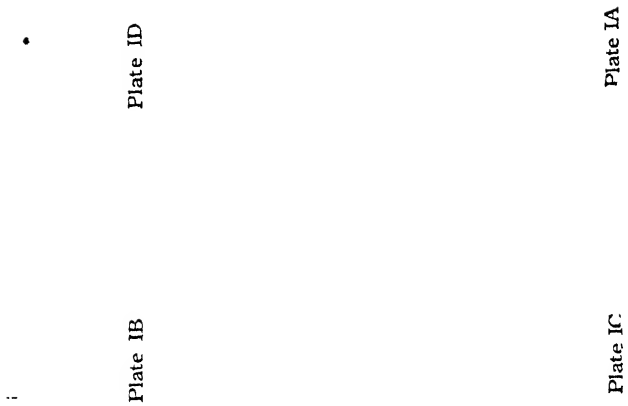


Fig 1



Transaction No. 9: On the Magnetic Moment of the Nucleus and Hyperfine
etc. by J. S. Badami.

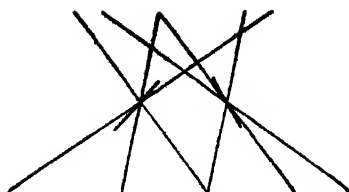


Fig. 2-(a).

Transaction No. 9: On the Magnetic Moment of the Nucleus and Hyperfine etc. by J. S. Badami.



Fig. 2-(b).

Transaction No. 9: On the Magnetic Moment of the Nucleus and Hyperfine etc. by J. S. Badami.

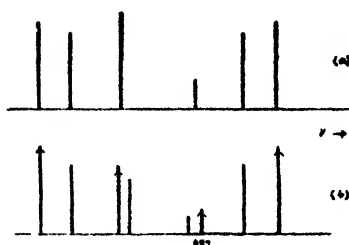


Fig. 3.

Transaction No. 9: On the Magnetic Moment of the Nucleus and Hyperfine Structures in the Spectrum of Doublyionized Antimony with a note on the Structure of the Arc Line by J. S. Badami.

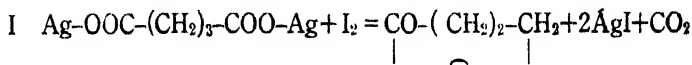
A STUDY IN THE DEGRADATION TO SUCCINIC ACIDS
THROUGH γ -BUTYRO-LACTONES AND OTHER RE-
ACTIONS OF β -ANISYL AND β -HALOGEN-
ANISYL GLUTARIC ACIDS.

BY

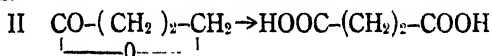
DATTATRAYA BALKRISHNA LIMAYE and RAGHUNATH GANESH CHITRE.

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During the investigation on Cholesterin, Windaus has obtained substituted glutaric acids as degradation products, and for the identification of these, a method was developed by Windaus and Klänhardt, (B. 54, 581-587) depending upon the action of iodine on the silver salts, when the γ -butyro-lactones are formed.



These lactones when oxidised give rise to the corresponding succinic acids.

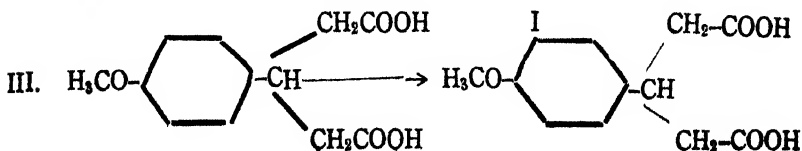


This reaction as regards β -substituted glutaric acids has been tried on alkyl substituted acids only.

Hence a study of the degradation of β -aryl-glutaric acids to the corresponding succinic acids through γ -butyro-lactones was undertaken and as a representative of the class of β -aryl glutaric acids, β -(4-methoxy-phenyl)-glutaric acid was chosen.

However as the work progressed it was found necessary to include β -(Halogen-anisyl)-glutaric acids also. Moreover the condensations of the ethyl-esters of the new glutaric acids with oxalic ester (Dieckmann, B. 32, 1930-35; 1899) have been studied and a number of functional derivatives have also been prepared.

When the silver salt of β -(4-methoxy-phenyl)-glutaric acid was heated with iodine the corresponding γ -butyro-lactone could not be obtained and a side reaction consisting in the substitution of iodine in the benzene ring took place.

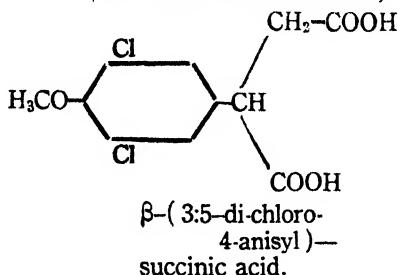
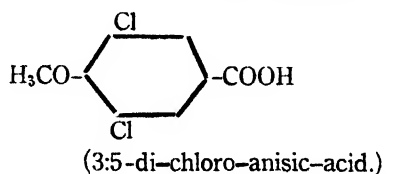
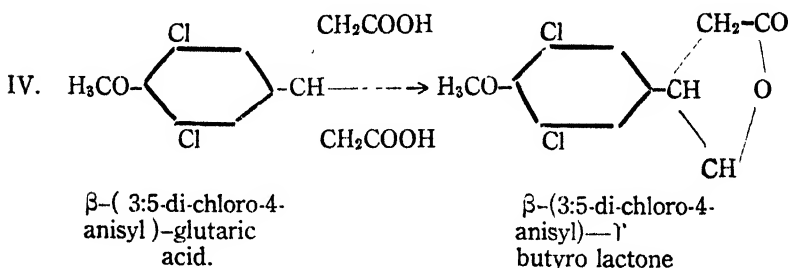


The reaction was then tried on β -phenyl-glutaric acid but in this case also the expected lactone was not obtained.

The β -(Halogenated-aryl)-glutaric acids were next tried. These acids were prepared by the halogenation of the β -(4-methoxy-phenyl)-glutaric acid.

In all, five halogenated acids were obtained namely β -(3-chloro-4-anisyl), β -(3-bromo-4-anisyl), β -(3-iodo-4-anisyl), β -(3:5-dichloro-4-anisyl), and β -(3:5-dibromo-4-anisyl)-glutaric acids.

The position of the halogens in the case of the mono-halogenated acids was determined by the direct oxidation to the corresponding known anisic acids; while in the case of the dihalogenated acids they were determined indirectly by the oxidation of the intermediate γ -butyro-lactones when the corresponding known anisic acids were obtained along with the new succinic acids.

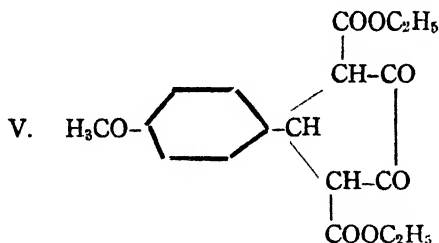


The degradation reaction on the mono-halogenated acids did not give the corresponding lactones while β -(3:5-di-bromo) and β -(3:5-di-chloro)-4-anisyl-glutaric acids gave the corresponding lactones (IV).

These lactones were further oxidised to β -(3:5-di-bromo) and β -(3:5-di-chloro)-4-anisyl-succinic acids, identical with those

obtained by halogenating β -(4-anisyl)-succinic acid prepared by Lapworth's method (Soc. 127, 560-567.); however an attempt to condense 3:5-di-bromo anisaldehyde with sodium-cyan-acetate to form (3:5-di-bromo-4-anisyl)-cyan-acrylic-acid, by Lapworth's method was not successful.

In the case of the condensation of the ethyl-esters of the glutaric acids with oxalicester to form compounds of the type (V), it was necessary to replace dry sodium ethoxide by finely divided sodium.



Di-ethyl-2-(4'-anisyl) - 4:5 diketo-pentamethylene 1:3-dicarboxylate.

Owing to the peculiar behaviour of β -(4-methoxy-phenyl)-glutaric acid, in giving the γ -butyro-lactones, only when two halogens are present in the benzene ring, it is intended to investigate the reaction in the presence of other negative substituents.

EXPERIMENTAL.

1. β -(4-Methoxy-phenyl)-glutaric acid (*m. p.* 164°C), the starting material of the investigation was obtained by the reduction with sodium amalgam of β -(4-methoxy-phenyl)-glutaconic acid (Limaye and Bhawe, J. Ind. Chem. Soc. 8, 137; 1931.)

2. β -(4-Methoxy-3-iodophenyl)-glutaric acid (*m. p.* 161°C). Following the method of Windaus and Klänhardt a mixture of 5 Gms. of silver salt of β -(4-methoxy-phenyl)-glutaric acid, 3 Grams of iodine, and 8 Gms of sand was heated for one hour in an oil bath at 150°C. The cooled reaction mass was extracted with ether and the ethereal solution was washed with dilute sodium-carbonate solution. The ethereal solution, on evaporation did not give the expected γ -butyro-lactone, but the carbonate solution on acidification gave a product, which on crystallization from hot water melted at 160°C. Yellow needles, soluble in alcohol and ether, insoluble in benzene. Analysis:—

Found—I = 34.8 per cent.; Equivalent = 180

$C_{12} H_{13} O_5 I$ requires I = 34.9 per cent.; „ 182

The constitution of this acid, as β -(3-iodo-4-methoxy-phenyl)-glutaric acid was proved by its oxidation to 3-iodo-anisic acid as in (III).

This acid is, however, more conveniently prepared by the following method :—

A mixture of 5 Gms. of β -(4-methoxy-phenyl)—glutaric acid, 2.5 Gms. of iodine, 1 Gm. of iodic acid and 25 c.cs. of water is heated in a sealed tube over a boiling water bath for eight hours. The mixture is then cooled, the contents are transferred to a shallow dish and the excess of iodine is evaporated on water bath. The neutralised solution of the crude acid is treated with barium chloride and is boiled till a considerable reduction in volume occurred, when the insoluble barium salt is precipitated. This, on treatment with hydrochloric acid gives pure acid m. p. 161°C , identical with that obtained by the silver salt method. Yield 4.2 Gms.

Barium salt :—

Found—Ba = 47.43 per cent.

$\text{C}_{12}\text{H}_{11}\text{IBa}$, requires—Ba = 47.46 per cent.

3. *3-Iodo-anisic acid* :—5 Gms. of β -(3-iodo-4-methoxy-phenyl)—glutaric acid from (2) were boiled with 25 c. cs. of 10 per cent potassium bi-chromate and 3 c. cs. of con. sulphuric acid on a sand bath under a reflux condenser for half an hour. The solid, that separated on cooling, was dissolved in sodium bi-carbonate solution ; on acidification the acid separated, which on crystallization from dil. acetic acid melted at 234°C . Soluble in benzene, alcohol, and acetic acid. Insoluble in water.

It gave no depression in melting point when mixed with the known 3-iodo-anisic acid (B. 17, 2533, 1884.)

4. β -(3-Bromo-4-methoxy-phenyl)—glutaric acid (m.p. 147°C) :—3 Gms. of β -(4-methoxy-phenyl)—glutaric acid were dissolved in 40 c.cs. of ether and to this solution was added 1 c.c. of bromine dissolved in ether. The mixture was allowed to stand for six hours. The insoluble solid which separated was washed with benzene and when recrystallized from hot water melted at 147°C . Yield 1.3 Gms. Soluble in alcohol, ether and dil. acetic acid. Insoluble in benzene. Analysis :—

Found —Br = 25.1 per cent. Equivalent = 158.

$\text{C}_{12}\text{H}_{13}\text{O}_5\text{Br}$ requires Br = 25.2 „ „ „ = 158.5

From the ethereal mother liquor a further yield of 0.4 Gms. of slightly impure β -(3-bromo-4-methoxy-phenyl)—glutaric acid could be recovered.

Barium salt — Found Ba = 30.2 per cent.

$\text{C}_{12}\text{H}_{11}\text{O}_5\text{Br.Ba}$ requires Ba = 30.3 „ „

5. *3-Bromo-anisic acid* :—(m.p. 217°C .) 1 Gm. of β -(3-bromo-4-methoxy-phenyl)—glutaric acid was oxidised by 3 Gms. of potassium bichromate, 2 c.cs. of con. sulphuric acid, and 40 c.cs. of

water as in (3). The pure acid melted at 217°C and was identical with the known 3-bromo-anisic acid prepared by directly brominating anisic acid (Annalen, 56,311).

6. β -(3-Chloro-4-methoxy-phenyl)—glutaric acid. (*m.p.* 157°C):—1 Gm. of β -(4-methoxy-phenyl)—glutaric acid was dissolved in 20 c.cs. of glacial acetic acid and chlorine gas generated from 1 Gm. of MnO_2 , 1 Gm. of NaCl and 4 c.cs. of con. sulphuric acid was passed through the solution. The acetic acid was then evaporated off on water bath and the crude acid was purified through its barium salt. *Mp.* 157°C . Yield 0.6 Gm. soluble in alcohol, ether, and acetic acid. Insoluble in benzene.

Analysis:— Found $\text{Cl} = 11.85$ per cent. Equivalent = 136

$\text{C}_{12} \text{H}_{13} \text{O}_5 \text{Cl}$ requires $\text{Cl} = 12.15$ „ „ „ = 136.3

Barium salt:— Found $\text{Ba} = 33.0$ per Cent.

$\text{C}_{12} \text{H}_{11} \text{O}_5 \text{Cl Ba}$ requires $\text{Ba} = 33.5$ „ „

7. 3-Chloro-anisic acid (*m.p.* 215°C):—It was prepared as in (3) from β -(3-chloro-4-methoxy-phenyl)—glutaric acid. It melted at 215°C and was found identical with the known 3-chloro-anisic acid obtained by chlorinating anisic acid (B. 17,2529).

8. β -(3:5-Dichloro-4-methoxy-phenyl)—glutaric acid. (*m.p.* 194°C):—1 Gm. of β -(4-methoxy-phenyl) glutaric acid was dissolved in 30 c.cs. of glacial acetic acid and a slow current of chlorine gas was passed through the solution for two hours. When the solution was saturated with the gas and assumed a yellow colour, the acetic acid was evaporated on water bath and the residue was boiled with water to remove soluble impurities. The insoluble dichloro-compound, when recrystallized from acetic acid melted at 195°C . Yield 0.8 gm. Insoluble in water and in benzene. Soluble in alcohol and in acetic acid.

Analysis:— Found $\text{Cl} = 23$ per cent. Equivalent = 152.8

$\text{C}_{12} \text{H}_{12} \text{O}_5 \text{Cl}_2$ requires $\text{Cl} = 23.1$ „ „ „ = 153.5

Barium salt:— Found $\text{Ba} = 30.9$ „ „

$\text{C}_{12} \text{H}_{10} \text{O}_5 \text{Cl}_2 \text{ Ba}$ requires $\text{Ba} = 30.9$ „ „

9. β -(3:5-Dichloro-4-methoxy-phenyl)— γ -butyro-lactone. (*mp.* 72°C):—5 Gms. of the silver salt of β -(3:5-dichloro-4-methoxy-phenyl)—glutaric acid were treated with iodine as in (2). The ethereal solution after being extracted with sodium carbonate was evaporated. The semi solid residue, on being treated with deci-normal caustic alkali soon solidified. The solid on re-crystallization from dil. alcohol melted at 72°C . Soluble in benzene, ether, acetic acid. Insoluble in water and dil. alkalies. It dissolved in boiling caustic alkalies but is reprecipitated unchanged on acidification. Yield 0.62 Gm.

Analysis:— Found $\text{Cl} = 27.3$ per cent.

$\text{C}_{11} \text{H}_{10} \text{O}_3 \text{Cl}_2$ requires $\text{Cl} = 27.1$ „ „

The compound resembled the γ -Butyro-lactones described by Windaus in its properties.

10. β -(3:5-Di-chloro-4-methoxy-phenyl)-succinic acid (*m.p.* 173°C.)—

Method I:— 1 Gm. of β -(3:5-di-chloro-4-methoxy-phenyl)- γ -butyro lactone was oxidized by 0.6 Gm. of potassium bichromate, 40 c.cs. of water and 1 c.c. of strong sulphuric acid on a boiling water bath for two hours. The solid that separated on cooling was dissolved in sodium bicarbonate solution and reprecipitated by acidification and crystallized from hot water, when two substances were obtained. The one soluble (A) and the other insoluble (B) in hot water. The soluble portion melted at 173°C. Soluble in alcohol, ether, and acetic acid. Insoluble in cold benzene. Yield = 0.12 Gm. This acid was identical with that obtained by directly chlorinating β -(4-methoxy-phenyl)-succinic acid as in method II.

Analysis:— Found Cl = 23.9 per cent. Equivalent = 147
 $C_{11}H_{10}O_5Cl_2$ Requires Cl = 24.2 „ „ „ = 146.5

Method II:— 5 Gms. of β -(4-methoxy-phenyl)-succinic acid (Lapworth and Baker, J.C.S. 127, 560) were dissolved in glacial acetic acid and chlorine gas was passed through in excess, as shown by the deep yellow colour of the solution. The acetic acid was evaporated on water bath and the residue was purified by crystallization from hot water, *m.p.* 173°C. Yield 2.5 Gms.

11. 3:5-Dichloro-anisic acid (*m.p.* 200°C.):— The insoluble portion (B) mentioned in (10) on crystallization from dil. acetic acid melted at 200°C. It was identified as 3:5 diachloro-anisic acid by means of its mixed melting point with the known compound (J.C.S. 123, 1426.)

12. β -(3:5-Di-bromo-4-methoxy-phenyl)-glutaric acid (*m.p.* 211°C.):— 2 Gms. of (4-methoxy-phenyl)-glutaric acid were mixed with 1 c.c. of bromine in a flask, and the reaction was moderated by cooling the mixture. It was allowed to stand for overnight and the reaction mass was boiled with water to remove soluble impurities. It was crystallized from acetic acid. *Mp.* 211°C. Soluble in ether, acetic acid and alcohol. Insoluble in water and benzene. Yield 0.9 Gm.

Analysis:— Found Br = 40.5 per cent. Equivalent = 197
 $C_{12}H_{12}O_5Br_2$ Requires Br = 40.5 „ „ „ = 198.

Barium salt:— Found Ba = 25.1 per cent.

$C_{12}H_{10}O_5Br_2Ba$ requires Ba = 25.7 „ „

13. β -(3:5 Di-bromo-4-methoxy-phenyl)- γ -butyro lactone (*m.p.* 98°C.):—It was prepared from β -(3:5-di-bromo-4-methoxy-

phenyl)-glutaric acid as in (9). On crystallization from dil. alcohol it melted at 98°C. Yield 0.62 Gm.

Analysis :— Found Br = 45.7 Per cent.

$C_{11}H_{10}O_5Br_2$ requires Br = 45.71 „ „

14. β -(3:5-Di-bromo-4-methoxy phenyl)-succinic acid (mp. 198°C.) :—The above lactone (13) was oxidised as the corresponding chloro-compound. The crude oxidation product was purified by crystallization from hot water when two portions were obtained, one soluble (A) and the other insoluble (B) in hot water. The soluble portion melted at 198°C. This acid could also be obtained by directly brominating β -(4-methoxy-phenyl)-succinic acid as in method II.

Analysis :— Found Br = 41.82 Per cent. Equivalent = 190.1

$C_{11}H_{10}O_5Br_2$ requires Br = 41.88 „ „ „ = 191

Method II :—5 Gms. of β -(4-methoxy-phenyl)-succinic acid (J. C. S. 127, 560) were treated with 2.5 c.cs. of bromine in a dry test tube. The mixture was warmed on a water bath under a reflux condenser for half an hour, and allowed to stand overnight. The reaction product was purified by crystallization from hot water. Mp 198°C. Soluble in alcohol, ether, and acetic acid. Insoluble in cold benzene.

15. 3:5-Di-bromo-anisic acid (m.p. 213°C.) :—During the oxidation of β -(3:5-di-bromo-4-methoxy-phenyl)- γ -butyrolactone a water insoluble product (B) was isolated along with the succinic acid. On crystallization from acetic acid it melted at 213°C. and was identified as 3:5-di-bromo-anisic acid by its mixed melting point with the known compound (Crepsi, G. 11,425).

16. Di-ethyl-2-(4'-methoxy phenyl)-4:5-diketo-pentamethylene 1:3 dicarboxylate (mp. 123°C.) :—2 Gms. of diethyl ester of β -(4-methoxy-phenyl)-glutaric acid were dissolved in 30 c.cs. of anhydrous ether; 1 Gm. of oxalic ester was added and the mixture was poured in a flask containing 0.3 Gm. of granulated-sodium dissolved. The flask was allowed to stand overnight when the sodium salt was decomposed by hydrochloric acid and extracted with ether. The ethereal layer was shaken several times with 1 to 2 c.cs. of dilute sodium hydroxide. The earlier extracts on acidification gave comparatively impure product while the later extracts immediately gave a solid, on acidification. It was further purified by crystallization from alcohol. Mp. 123°C. Yield 0.8 gram. Soluble in alcohol and ether. Insoluble in sodium bicarbonate solution. Its alcoholic solution gave a dark violet coloration with ferric chloride.

Analysis :— Found C = 62.01 ; H = 5.8 per cent

$C_{18}H_{20}O_7$ requires C = 62.07 ; H = 5.74 „ „

Similar products were obtained when this reaction was applied to β -(halogen-4-methoxy-phenyl)-glutaric acids.

The following table contains various derivatives such as anhydrides, esters, semi-anilides etc, obtained from the glutaric and succinic acids during the course of the investigation.

Analysis

Substance. M.P. °C. Formula. Found per cent. Required per cent.

From β -(4-Methoxy-phenyl)-glutaric acid.

1. Anhydride*	152	$C_{12}H_{12}O_4$	C=64.78 H=5.23	C=64.86 H=5.4
2. Semianilide	157	$C_{18}H_{15}O_4N$	C=68.82 H=5.9	C=69.02 H=6.07
3. Diethylester*	B.P. 206/14mm.	$C_{16}H_{17}O_5$	C=65.1 H=7.39	C=65.31 H=7.48
4. Acid-ester	78	$C_{14}H_{13}O_5$	C=62.89 H=6.53	C=63.16 H=6.76
5. Phenacyl ester	95	$C_{28}H_{19}O_7$	C=70.7 H=5.39	C=70.9 H=5.4

From β -(3-Iodo-4-anisyl)-glutaric acid.

6. Anhydride	148	$C_{12}H_{11}O_4I$	I=37.2	I=37.29
7. Semianilide	182	$C_{18}H_{13}O_4NI$	I=28.9	I=28.93
8. Diethylester	83	$C_{16}H_{21}O_5I$	I=30.19	I=30.24
9. Dimethylester	79	$C_{14}H_{17}O_5I$	I=32.25	I=32.4
10. Phenacyl ester	131	$C_{28}H_{19}O_7I$	I=20.8	I=20.16

From β -(3-Bromo-4-anisyl)-glutaric acid

11. Anhydride	143	$C_{12}H_{11}O_4Br$	Br=26.5	Br=26.75
12. Semianilide	150	$C_{18}H_{13}O_4NBr$	Br=20.0	Br=20.4
13. Diethylester	66	$C_{16}H_{21}O_5Br$	Br=21.3	Br=21.45
14. Dimethylester	74	$C_{14}H_{17}O_5Br$	Br=22.8	Br=23.19
15. Phenacyl ester	125	$C_{28}H_{19}O_7Br$	Br=14.4	Br=14.46

From β -(3-Chloro-4-anisyl)-glutaric acid

16. Anhydride	128	$C_{12}H_{11}O_4Cl$	Cl=13.72	Cl=13.92
17. Semianilide	143	$C_{18}H_{13}O_4Cl$	Cl=9.9	Cl=10.22
18. Diethylester	40.5	$C_{16}H_{21}O_5Cl$	Cl=10.65	Cl=10.8
19. Dimethylester	59	$C_{14}H_{17}O_5Cl$	Cl=11.77	Cl=11.83

* Already described by Jackson and Kenner, J.C.S. 1924, 1660.

Analysis

Substance	M.P. °C.	Formula	Found per cent.	Required per cent.
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From β (3 : 5-Di-chloro-4-anisyl)-glutaric acid

20. Anhydride	182	$C_{12}H_{10}O_4Cl_2$	Cl=24.1	Cl=24.57
21. Semianilide	172	$C_{18}H_{17}O_4NCl_2$	Cl=18.5	Cl=18.55
22. Diethylester	B.P. 320Decomp	$C_{16}H_{20}O_6Cl_2$	Cl=17.8	Cl=17.84
23. Dimethylester	63.5	$C_{14}H_{16}O_5Cl_2$	Cl=21.0	Cl=21.19
24. Phenacylester	120	$C_{28}H_{24}O_4Cl_2$	Cl=12.8	Cl=13.08

From β -(3 : 5-Dibromo-4-anisyl)-glutaric acid.

25. Anhydride	233	$C_{12}H_{10}O_4Br_2$	Br=41.9	Br=42.3
26. Semianilide	180	$C_{18}H_{17}O_4NBr_2$	Br=33.9	Br=33.97
27. Diethylester	B. P. 315Decomp.	$C_{16}H_{20}O_6Br_2$	Br=35.1	Br=35.4
28. Dimethylester	62	$C_{14}H_{16}O_5Br_2$	Br=37.69	Br=37.73

From Diethyl 2-(R) 4 : 5-diketo-pentamethylene-1-3-dicarboxylates

29. R=3-Chloro -4-anisyl	126	$C_{13}H_{19}O_7Cl$	Cl=9.12	Cl=9.28
30. R=3-Bromo -4-anisyl	129	$C_{13}H_{19}O_7Br$	Br=18.6	Br=18.74
31. R=3-Iodo-4 -anisyl	133	$C_{13}H_{19}O_7I$	I=26.6	I=26.8
32. R=3-5-Di- chloro-4-anisyl	164	$C_{13}H_{13}O_7Cl_2$	Cl=16.93	Cl=17.03
33. R=3-5-Di- bromo-4-anisyl	168	$C_{13}H_{13}O_7Br_2$	Br=31.2	Br=31.6

From 3 : 5-Dibromo-anisaldehyde

34. Semi-carbazone	236 Decomp.	$C_9H_9O_2Br_2N_2$	Br=47.5	Br=47.62
35. Phenyl-hydro- zone	135	$C_{13}H_{10}OBr_2N_2$	Br=43.1	Br=43.24

From β - (3 : 5-Dibromo-4-anisyl)-succinic acid :—

36. Anhydride	110	$C_{11}H_9O_4Br_2$	Br=43.9	Br=43.93
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From β - (3 : Bromo-4-anisyl)-succinic acid :—

37. Anhydride	168	$C_{11}H_9O_4Br$	Br=27.8	Br=28.0
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Analysis

Substance.	M.P. °C.	Formula.	Found per cent.	Required per cent.
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(3 - Bromo-4-anisyl)-succinic acid :—

38. (3-Bromo-4-anisyl)-succinic acid	175	$C_{11}H_{11}O_5Br$	Br=26.28 Equi=151	Br=28.0 Equi=152
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From (3 : 5-Dibromo-4-hydroxy)-benzaldehyde :—

39. Semi-carbazone of	233 Decomp.	$C_8H_5O_2Br_2N_2$	Br=49.6	Br=49.68
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A NOTE ON THE CONDENSATION OF ETHYLENE CHLORHYDRIN WITH RESORCINOL.

BY

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INTRODUCTION

As a preliminary to the preparation of *2-hydroxy-4-(β -hydroxy-ethoxy)-acetophenone* which was required in an attempt to synthesise dihydrofuranflavone (Motwani and Wheeler, J. C. S., 1935, 1098), ethylene chlorhydrin was condensed with resorcinol. Two ethers have been obtained (i) *m-(β -hydroxy-ethoxy)-phenol* and (ii) *1:3 di-(β -hydroxy-ethoxy)-benzene*, of which the former is new. Rindfusz, Ginnings and Harnack (J. A. C. S., 1920, 42, 157) condensed ethylene chlorhydrin with resorcinol in presence of sodium ethylate and obtained an impure di-ether. They did not isolate the mono-ether, which contaminated the di-ether. In the present work the condensation was effected in presence of aqueous alkali. This aqueous alkali method is better, in that the completion of the reaction, in the case of insoluble ethers, is marked by the aqueous layer losing its colour, which is initially red. The di-ether has now been obtained in a pure state.

EXPERIMENTAL

m-(β hydroxy-ethoxy)-phenol. A solution of resorcinol (1 mol.; 22g) in 40% KOH (1 mol.; 28 cc.) was refluxed with ethylene chlorhydrin (1mol.; 16g.) at 100° for 3 hours. The reaction mixture was filtered from potassium chloride and extracted with ether. After removal of the ether, the extract was fractionally distilled. Three portions were collected at 2 mm. and identified.

- I b.p 160–170° about 3 g. ; resorcinol ;
- II „ 185–195° about 10g. ; *m-(β -hydroxy-ethoxy)-phenol* ;
- III „ 200–210° about 5–6g. ; mixture of II and the di-ether.

m-(β -hydroxy-ethoxy)-phenol was soluble in alkali and gave a bluish-black coloration with aqueous ferric chloride. (Found C, 62.5; H, 6.0; $C_8H_{10}O_3$ requires C, 62.3; H, 6.5 %). The *diacetyl* derivative crystallised from rectified spirit in thin plates, m. p. 75°. (Found C, 60.4; H, 6.0; $C_{12}H_{14}O_5$ requires C, 60.5; H, 5.9%). The *dibenzoyl*

derivative crystallised from dilute alcohol in microscopic needles, m. p. 90–91°. (Found C, 72.8; H, 5.2; $C_{22}H_{18}O_6$ requires C, 72.9; H, 5.0%) The ether (1 mol.) and phosphorous pentachloride (2 mols.) were refluxed at 130–135° for an hour. The oil distilled and collected at 165–170°/2 mm. was hydrolysed when *m*-(β -hydroxy-ethoxy)-chlorobenzene was obtained. It crystallised from benzene in prismatic needles, m. p. 78–79°. It is insoluble in alkali and does not give any coloration with ferric chloride. (Found Cl, 20.4; $C_8H_9O_2Cl$ requires Cl, 20.6%).

1:3-di-(β -hydroxy-ethoxy)-benzene. A solution of resorcinol (1 mol.; 22 g.) in 40% KOH (2.25 mol.; 63 cc.) was refluxed with ethylene chlorhydrin (2.25 mols.; 36 g.) at 100° for 3 hours. The thick oil which was insoluble in ether was separated from the aqueous layer and kept overnight in the refrigerator. The separated solid was filtered off, and a further quantity collected by cooling the filtrate in freezing mixture. Total yield, 18 g. It crystallised from hot water in thin pinkish needles, m.p. 95–96°. (Rindtusz and others, *loc. cit.*, give 81°). (Found C, 60.5; H, 7.1; $C_{10}H_{14}O_4$ requires C, 60.6; H, 7.1%). The *diacetyl* derivative crystallised from aqueous alcohol in prismatic needles, m. p. 75–76°. (Found C, 59.5; H, 6.5; $C_{14}H_{18}O_6$ requires C, 59.6; H, 6.4%). The *dibenzoyl* derivative crystallised from aqueous alcohol in microscopic needles, m. p. 110°. (Found C, 70.8; H, 5.6; $C_{24}H_{22}O_6$ requires C, 70.9; H, 5.4%). When the ether (1 mol.) was treated with phosphorous pentachloride (2 mols.) at 100° for an hour and the resulting oil distilled at 1 mm., *1:3 di-(β -chloro-ethoxy)-benzene* coming over at 130–150°, solidified on cooling. It crystallised from p. ether in prismatic needles, m. p. 63–64°. (Found Cl, 30.0%; $C_{10}H_{12}O_2Cl_2$ requires Cl, 30.2%).

(Received July 6, 1935)

A NEW METHOD FOR THE SYNTHESIS OF α SUBSTITUTED GLUTACONIC ACIDS.

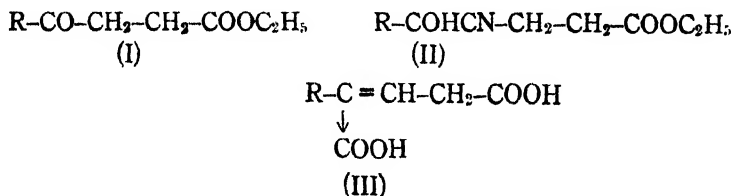
By

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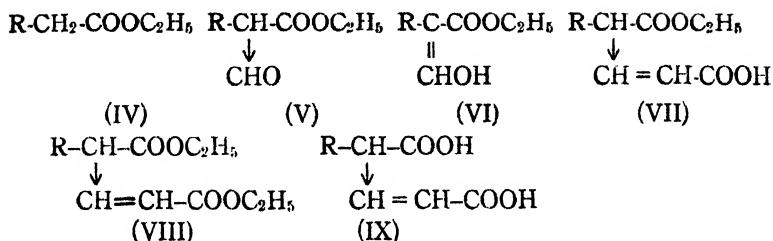
The only methods at present available for the synthesis of α substituted glutaconic acids are based on the alkylation of the parent acids. Thus Conrad and Gutzeit (Ann 1880 222 257) prepared the alkylated glutaconic acids by alkylating the yellow sodium compound which they obtained by the action of chloroform on the sodium compound of ethyl malonate. This method has been further extended by Thorpe (J.C.S. 1911 T 2191). The method, however, cannot be applied for the preparation of α phenyl glutaconic acid, because a phenyl radical cannot be introduced like an alkyl radical due to the unreactivity of the halogen substitution products of benzene. The present work was undertaken with a view to devise a general method which could be utilised for the synthesis of α phenyl glutaconic acid.

An attempt was first made to use the following reactions for this purpose. A ketonic ester (I) on treatment with hydrocyanic acid would yield a cyanohydrin (II). This on dehydration followed by hydrolysis would give the glutaconic acid (III).



This method though useful for the preparation of α methyl glutaconic acid, is, however, useless for the synthesis of α phenyl glutaconic acid because the cyanohydrin of ethyl β benzoyl propionate (II when R = C₆H₅) could not be obtained.

The following scheme represents a method by which an α substituted glutaconic acid can be prepared.



Wislicenus (Ber 20 2930) has shown that an ester having a CH_2 group next to the carbethoxyl group can be condensed with ethyl formate in presence of molecular sodium or sodium ethoxide to give a mixture of aldehydic ester (V) and a hydroxy methylene ester (VI). The aldehydic ester can then be condensed with malonic acid in presence of pyridine and piperidine yielding the acid ester of the glutaconic acid (VII). For the sake of purification it is convenient to convert the acid ester (VII) into the di-ester (VIII). This on hydrolysis gives the glutaconic acid (IX).

In practice it is not necessary to separate the compounds (V) and (VI). The condensation product containing the compounds (V) and (VI) can with advantage be used for the further synthesis.

This method has been used for the preparation of the following known glutaconic acids :

- I. α methyl glutaconic acid.
- II. α benzyl glutaconic acid.

It has been used for the preparation of the hitherto unknown α phenyl glutaconic acid. The study of the derivatives of α phenyl glutaconic acid is in progress.

It is interesting to note that the glutaconic acids obtained by this method are the trans-acids.

(Experimental)

α methyl glutaconic acid :—

A mixture of ethyl formate (37 grms.) and ethyl propionate (57 grms.) was added to molecular sodium (11.5 grms.) suspended in dry ether (500 cc.) and cooled in a freezing mixture. After ice was added the ether layer containing the unreacted substances was removed. The aqueous layer was acidified with cold dilute sulphuric acid, extracted with ether and the ethereal solution was dried over calcium chloride and the product recovered. The yield was 20 grms. This was condensed with malonic acid (16 grms.) in presence of pyridine (15 grms.) and piperidine a few drops by heating on the water bath for 5 hours. The condensation proceeded with

copious evolution of carbon dioxide. The cooled product was poured in dilute hydrochloric acid and extracted with ether. The ethereal solution was dried over calcium chloride and the product recovered. The acid ester of α methyl glutaconic acid could not be purified by vacuum distillation. Hence the above ester (17 grms.) was refluxed with absolute alcohol (70 grms.) saturated with dry hydrogen chloride. Ethyl α methyl glutaconate, [formula VIII $R = CH_3$] which is obtained in the quantitative yield, had B. P. 180-185° at 120 m.m. Thorpe and Wood [J.C.S. 1913 T 1579] give B.P. 165° at 60 m.m. This ester on hydrolysis either by acid or by alkali yields trans α methyl glutaconic acid m.p. 144° identical with an authentic specimen of trans. α methyl glutaconic acid prepared according to the method of Thorpe and Wood [Loc. cit.].

α Benzyl glutaconic acid :—The condensation of ethyl hydrocinnmate (36 grms.), ethyl formate (15 grms.), sodium (4.6 grms.) and dry ether (400 c. c.) yielded 17 grms. of the mixture of compounds (V) and (VI) [where $R = C_6H_5-CH_2$]. This crude condensation product was condensed with malonic acid (9 grms.) in presence of pyridine (8 grms.) and a few drops of piperidine. The yield of the mono-ester of α benzyl glutaconic acid was 16 grms. It was converted into the diester in the usual way. Ethyl α benzyl glutaconate [yield 8 grms.] had B. P. 187° at 20 m. m. [Compare Bland and Thorpe J.C.S. 1912 T 886.] On acid hydrolysis this gave trans α benzyl glutaconic acid m. p. 152°, equivalent wt. 111. It was identical with the trans α benzyl glutaconic acid of Bland and Thorpe. [loc. cit.]

α Phenyl glutaconic acid :—Ethyl phenyl acetate (71 grms.) ethyl formate (38 grms.), sodium (11.5 grms.) and dry ether (400 c.c.) gave 60 grms. of the condensation product. The whole of it when treated with malonic acid (30 grms.), pyridine (25 grms.) and piperidine a few drops gave 60 grms. of the acid ester of α phenyl glutaconic acid. It was then converted into diester. Ethyl α phenyl glutaconate [formula VIII $R = C_6H_5$] had B. P. 220° at 80 m. m., density at 30° 1.0712 and refractive index at 30° 1.50923. On hydrolysis it gave α phenyl glutaconic acid m. p. 164°, equivalent wt. 103.5. The silver salt contained 51.11 per cent. of silver.

[Found : C, 64.15 ; H, 4.78 $C_{11}H_{10}O_4$ requires C, 64.07 ; H, 4.85.
Equivalent wt. = 103.0]

Our best thanks are due to the University of Bombay for a grant to one of us [K.S.N.] for research.
Madhavlal Ranchodlal Science Institute,

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C-ALKYL RESORCINOLS. I.—4 : 6-DIETHYLRESORCINOL AND ITS REACTIONS.

By

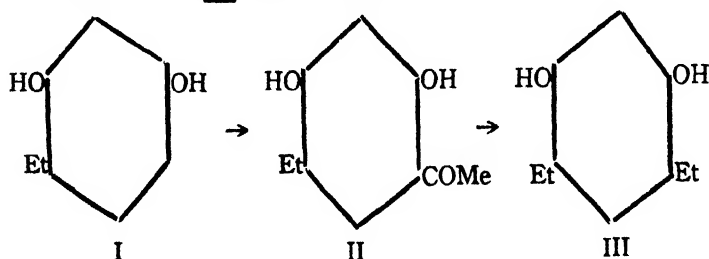
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C-alkyl resorcinols have recently attracted considerable attention for the last few years from the point of view of chemical constitution and antiseptic activity. They have also an interest of their own, as many C-alkyl resorcinol derivatives are encountered as degradation products of naturally occurring substances like lichens etc.

Samant has, in this laboratory, exhaustively studied the chemistry of 4-ethylresorcinol (Bombay University M. Sc. Thesis, 1935). In the present work, the chemical reactions of 4 : 6-diethylresorcinol which appears to have been little studied, have been investigated.

4 : 6-Diethylresorcinol (III) was synthesised from 4-ethylresorcinol (I) essentially by the method of Weiss and Kratz (Monatsch., 1929, 51, 386) as follows:—



5-ethylresorcinol (II) was prepared (i) by the Nencki reaction (Weiss and Kratz, loc. cit.), and also (ii) by the Höesch reaction. Its constitution is established by the fact that it yields, on reduction 4 : 6-diethylresorcinol, identical with the reduction product of 4 : 6-diacetylresorcinol, whose constitution has been definitely proved by Baker (J., 1934, 71).

The ketone was characterised by its phenylhydrazone, oxime, semicarbazone and the dibenzoyl derivative. Bromination in chloroform solution with 1 mol. of bromine gave a monobromo compound, 5-ethyl-2 : 4-dihydroxy-3-bromoacetophenone; with excess of bromine a tribromo derivative, 5-ethyl-3-*w-w*-tribromo-2 : 4-dihydroxy acetophenone was obtained. Clemmensen reduction of the

ketone yielded 4 : 6-diethylresorcinol (Klarmann, J. Amer. Chem. Soc., 1926, 48, 2358; Weiss and Kratz, loc. cit. : Rosenmund, Buchwald and Deligiannis, Arch. Pharm., 1933., 271, 342).

The phenol gave a sparingly soluble p-nitrobenzoyl derivative and afforded a monocarbomethoxy derivative on carbomethoxylation. It coupled with benzenediazonium chloride forming 2 : 6-dihydroxy-3 : 5-diethyl-azobenzene. Mercuration with mercuric acetate gave 4 : 6-diethyl-2-acetoxy mercury-resorcinol, while condensation with formaldehyde in acid medium afforded 2 : 6 : 2' : 6'-tetrahydroxy-3 : 5 : 3' : 5'-tetraethyl diphenyl methane. The two latter compounds are expected to be of particular interest from the point of antiseptic activity. Condensation with malic acid and acetoacetic ester by the method of Pechmann and Duisberg (Ber., 1883, 16, 2119) in the presence of 75% sulphuric acid. gave 6 : 8-diethyl-5-hydroxy coumarin and 4-methyl-6 : 8-diethyl-5-hydroxy coumarin respectively. These 5-hydroxy-coumarin derivatives are of interest as the α -pyrone ring closure takes place in position 2 in the resorcinol nucleus.

EXPERIMENTAL.

4-Ethylresorcinol. Resacetophenone prepared by the simplified method of Robinson and Shah (J., 1934, 1494) was reduced with zinc amalgam, prepared by the improved process of the same authors (loc. cit.).

5-Ethylresacetophenone. (i) By the Nencki-Sieber method :—Fused zinc chloride (50 g.) was dissolved in boiling glacial acetic acid (50 c.c.) and 4-ethyl resorcinol (33 g.) added to the cooled mixture, which was then boiled for 1-2 minutes and then allowed to cool. Dilute (1 : 1) hydrochloric acid (100 c.c.) was added to the cold mixture, when crystals began to separate. After a few hours the crystals were collected, and crystallised from hot benzene in rhombic plates m. p. 118-119°. Yield 35 g. Weiss and Kratz (loc. cit.) give m. p. 115° and Rosenmund, Buchwald and Deligiannis (loc. cit.) give m. p. 118-119°.

(ii) By the Höesch method :—To a solution of 4-ethylresorcinol (7 g.) and acetonitrile (3.2 g) in dry ether (40 c. c.), powdered fused zinc chloride (2 g.) was added, and dry hydrogen chloride passed into the mixture, cooled by a freezing mixture. The ketimide hydrochloride began to separate after two hours, after which hydrogen chloride was passed for one hour more. After leaving overnight in the frigidaire, the ether was poured off, and the crystalline precipitate (5 g.) after washing with dry ether was crystallised from glacial acetic acid in white shining plates m. p. 245° (Found : Cl, 16.2,

$C_{10}H_{14}O_2NCl$ requires, cl, 16. 5%). The crystals were boiled with dilute (1 : 1) hydrochloric acid (100 c. c.) for 2 hours. On cooling grayish plates of the ketone separated, which were collected and crystallised from benzene in rhombic plates m. p.—and mixed m. p. with the product from (i), 118–119°.

Dibenzoyl derivative. A mixture of the ketone (1 g.), benzoyl chloride (2 g.) and pyridine (10 c.c.) was left at ordinary temperature overnight. It was then acidified with dilute sulphuric acid, and the semisolid mass was extracted with ether. The ether extract was repeatedly washed with dilute sodium hydroxide and finally with water. The oily residue from ether extract solidified after standing several days in the frigidaire. The solid 2 : 4-benzoyloxy-5-ethylacetophenone crystallised from dilute alcohol in colourless needles m. p. 91–92°. It is insoluble in alkali and does not give coloration with alcoholic ferric chloride (Found: C, 74.6; H, 4.8. $C_{24}H_{20}O_6$ requires C, 74.2; H, 5.1%).

The phenylhydrazone prepared by boiling together phenylhydrazine hydrochloride, sodium acetate and the ketone in dilute acetic acid solution for 3 hours, crystallised from dilute alcohol in yellow shining plates m.p. 232–233° (Found: N, 10.0. $C_{18}H_{13}O_2N_2$ requires, N, 10.4).

The oxime, prepared by the usual method, crystallised from benzene in colourless plates m. p. 141–143° (Found: N, 7.2. $C_{10}H_{13}O_3N$ requires N, 7.2%).

The semicarbazone was readily obtained by refluxing a mixture of the ketone, sodium acetate and semicarbazide hydrochloride for 2 hours in aqueous alcoholic solution. It is sparingly soluble in most solvents and was crystallised from boiling glacial acetic acid in yellow needles m.p. 300–302° (Found: N, 17.6. $C_{11}H_{15}O_3N_3$ requires N, 17.7%).

5-Ethyl-2 : 4-dihydroxy-3-bromo-acetophenone :—Bromine (1.6 g) in chloroform solution was added to the ketone (1 g.) dissolved in the same solvent, when fumes of hydrogen bromide were evolved. The mixture was left overnight and on evaporation of the chloroform, yellowish oily globules separated, which solidified to a yellow crystalline mass. The solid bromo compound crystallised from alcohol in pale yellow needles m.p. 123–125°. Mixed m.p. with 2 : 4-dihydroxy-5-ethylacetophenone, 91–97° (Found: Br, 30.7. $C_{10}H_{11}O_3Br$ requires Br, 30.9%). It is easily soluble in the common organic solvents.

5-Ethyl-3- ω - ω -tribromo-2 : 4-dihydroxyacetophenone :—The bromination was carried out as in the preceding case, but

excess (4 g.) of bromine was used. Evaporation of chloroform, left a crystalline, yellow solid, which on crystallisation from rectified spirit was obtained in flat yellow needles m.p. 144–145°. Mixed m.p. with the monobromo compound was 95–100°. It is much less soluble than the monobromo compound (Found: Br, 57.7. $C_{10}H_9O_3Br_3$ requires Br, 57.60 %).

4:6-Diethylresorcinol was obtained by reduction of 5-ethylresacetophenone with hydrochloric acid and zinc amalgam prepared by the improved method of Robinson and Shah (loc. cit.). It distilled as a colourless oil at 150–151°/7 mm., and crystallised from benzene-petroleum in colourless rhombic plates which softened at 55°, and then melted at 65°–67°. Rosenmund, Buchwald and Deligiannis (loc. cit.) and Klarmann (loc. cit.) give m.p. 71°, Weiss and Kratz (loc. cit.) give m.p. 65–71°. It slowly turns brown and pasty on exposure to air.

Dip nitrobenzoyl derivative was prepared by shaking together an ethereal solution of p nitrobenzoyl chloride and a sodium hydroxide solution of the phenol. The derivative which separated in long needles was obtained by crystallisation from acetone-ethyl alcohol in needles m. p. 163–165° (Found : N, 6.0. $C_{24}H_{20}O_8N_2$ requires N, 6.1 %).

Monocarbomethoxy derivative. A mixture of the phenol (2 g.) dissolved in 2N sodium hydroxide solution and methylchlorocarbonate (3.3 g.) was shaken for two hours. The semisolid mass which separated was kept on the porous plate, and the solid residue was crystallised from petroleum ether (b. p. 65–95°) in colourless shining flat needles m. p. 83–85°. It is soluble in alkali and in the common organic solvents (Found : C, 64.3; H, 7.2. $C_{12}H_{18}O_4$ requires C, 64.3; H, 7.2 %).

2:6-Dihydroxy3-:5-diethylazobenzene :—4:6-Diethylresorcinol (0.9 g.) dissolved in normal sodium hydroxide was cooled in ice, and a cooled solution of diazobenzene chloride (from 2 g. of aniline) was gradually added with constant stirring. The separated sticky solid was dissolved in hot dilute alcohol, from which it separated in chocolate coloured needles m.p. 89°. It is very soluble in the usual organic solvents (Found : N, 10.5. $C_{18}H_{18}O_2N_2$ requires N, 10.4%).

4:6-Diethyl-2-acetoxymercuryresorcinol :—The phenol (1g.) in alcoholic solution was added to a suspension of mercuric acetate (2 g.) in the same solvent. The mixture turned yellow and then pink and a pinkish coloured precipitate began to separate. After some hours, the precipitate was collected and crystallised from hot

glacial acetic acid in colourless shining plates. It blackens at 200° and does not melt even at 300° (Found : Hg, 46.6. $C_{12}H_{18}O_4$ Hg requires Hg, 47.0%).

Condensation with formaldehyde :—2:6-2':6'-tetrahydroxy-3:5-3':5'-tetraethyl-diphenylmethane :—Formaldehyde solution (40%; 0.5 c. c.) was added to a suspension of 4:6-diethyl-resorcinol (1 g.) in 2N hydrochloric acid (40 c. c.) and the mixture after being thoroughly shaken was left overnight. The crystalline solid which had separated was collected and crystallised from benzene petroleum ether in rectangular plates m. p. 119° (Found : C, 71.5; H, 8.3. $C_{21}H_{28}O_4$, 0.5 H_2O requires C, 71.4; H, 8.2%).

6:8-Diethyl-5-hydroxy coumarin :—Concentrated sulphuric acid (75%; 25 c. c.) was added gradually to a mixture of 4:6-diethyl-resorcinol (3 g.) and malic acid (2–5 g.). The mixture was left overnight and then heated on the boiling water bath for 1 hour, cooled and then poured into water. The separated solid was crystallised from rectified spirit in shining plates having a pinkish tinge m. p. $148-149^{\circ}$ (Found : C, 71.4; H, 6.4. $C_{13}H_{14}O_3$ requires C, 71.6; H, 6.4%).

4-Methyl-6:8-diethyl-5-hydroxy-coumarin :—The phenol (3 g.) and ethyl acetoacetate (2.4 g.) were mixed together and concentrated sulphuric acid (75%; 8 c. c.) was added. Much heat was developed and a deep orange viscous liquid resulted. It was allowed to stand at room temperature for 1 hour, then heated for 1 hour on the boiling water bath, and after cooling poured into ice-water (150 c.c.). The yellow precipitate was collected and after crystallisation from rectified spirit was obtained in greyish flat needles m.p. $169-170^{\circ}$ (Found : C, 72.8; H, 7.1. $C_{14}H_{16}O_3$ requires C, 72.4; H, 6.9%).

The authors are thankful to Dr. T. S. Wheeler, Principal of the Royal Institute of Science, Bombay and to Dr. M. B. Rehman, Principal of the Ismail College, Andheri for their encouragement during the progress of the work.

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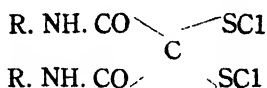
INTERACTION OF SELENIUM OXYCHLORIDE WITH THE SUBSTITUTED AMIDES OF MALONIC ACID.

BY

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College, Baroda.*

Ever since the study of the nature of the hydrogens of the reactive methylene (CH_2) group situated between two negative groups was undertaken in these laboratories, efforts have been made to replace these hydrogens of the reactive methylene group by various groups and to study the effect of the adjacent radicals on such replacements. The chlorides of sulphur gave many fruitful results. Sulphur monochloride gave dithioketones and dithioethers, (Naik, J. C. S. T., 1221., 119, 379-1166); while sulphur dichloride yielded compounds of the type



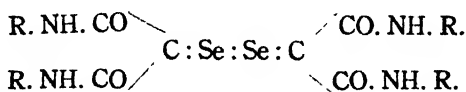
(Naik & Jadhav, J. I. C. S. 1926, 3, 260).

Reactions with Thionyl chloride also gave two types of products:

(i) Sulphoxides

and (ii) Sulphides. (Naik & Parekh, J. I. C. S. 1930, 7, 145).

From the study of these interactions it was expected that the chlorides of selenium, being of a nature similar to that of sulphur chlorides, would also react in a similar manner. A study of the interaction of selenium tetrachloride with substances containing reactive methylene group or a substituted methylene group revealed the formation of the selenides of the type:—

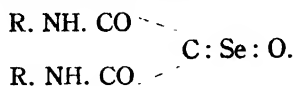


(Naik & Trivedi, J. I. C. S., 1930, 7, 239.)

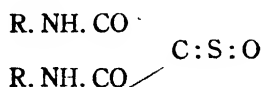
In the present study it was thought interesting to study the interactions between selenium oxychloride (SeOCl_2) and substances containing the reactive methylene group situated between two carbonyl groups. For these purposes the following substances were selected:—

- (1) Malonanilide $(\text{C}_6\text{H}_5\text{NH} \cdot \text{CO})_2\text{CH}_2$
 (2) Malon-diorthotolyl amide. $(\text{C}_7\text{H}_7\text{NH} \cdot \text{CO})_2\text{CH}_2$ -ortho.
 (2) Malon-diparatolyl amide. $(\text{C}_7\text{H}_7\text{NH} \cdot \text{CO})_2\text{CH}_2$ -para.

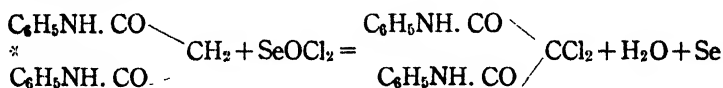
It was expected that as in the case of the interaction of these substances with thionyl chloride (Naik & Parekh, loc. cit.) this reaction would also yield the Selenoxides of the type :—



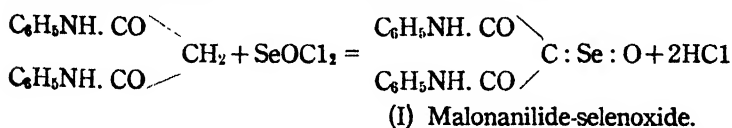
The corresponding sulphoxides obtained by Naik & Parekh (loc. cit.) were given the structure



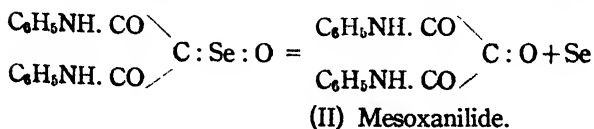
Accordingly, the reaction of selenium oxychloride with malonanilide was studied at the outset. Selenium oxychloride and malonanilide in anhydrous ether at room temperature gave dichlor-malonanilide and selenium as follows :—



In boiling anhydrous benzene the reaction proceeded in a different way and the product obtained was identified as mesoxanilide m.p. 191°C . This substance has also been obtained by J. U. Nef (J. C. S. A., 1892, 62, 1440). The interaction could be represented as taking place in two stages: At first the selenoxide is formed:

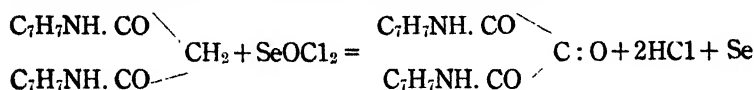


In the next stage the substance (I) seems to decompose as under :—



That the substance (I) may decompose to give rise to (II) is not surprising in view of the experimental conditions, as also in view of the fact that the selenoxide is more unstable than the corresponding sulphoxide. This is also supported by an observation viz., "...the selenium atom is far more labile than the sulphur atom in the corresponding thiocompounds." (Schmidt, Ber., 1921, 54 (B), 2067-2070).

The interaction of malondiorthotolylamide and malondiparatolylamide with selenium oxychloride followed the same course giving rise to the respective mesox-derivatives as follows:—



EXPERIMENTAL.

(i) *Interaction of malonanilide with Selenium oxychloride:*

Equimolecular quantities of selenium oxychloride and the amide were kept suspended in 50 c. cs. of anhydrous ether prepared by distilling it over sodium as well as over phosphorous pentoxide. The amide went into solution very slowly and during the interaction hydrogen chloride was found to evolve imperceptibly, after standing for 24 hours the dark red reaction mixture deposited fine silky needles. This reaction product (in the case of malonilide) was purified when fine white needles were obtained. On analysis and further identification these were revealed to be the crystals of dichloromalonanilide, m. p. 127°C. (Naik & Shah, J. I. C. S., 1927, 4, 11). The mother liquor was allowed to stand for a few days more but nothing separated out except a film of grey metallic selenium. The reaction seems to take place as represented on page (115)

It was then thought interesting to revise the experimental conditions to see if such a revision secured different results. The reaction was, accordingly, carried out in boiling anhydrous benzene solution with equimolecular quantities (Malonanilide 5gms. and selenium oxychloride 3.5 gms.) of the reactants as in the previous case. After refluxing for 24 hours a dark red solution of the reaction product was obtained. This was concentrated and was then added dropwise into a large amount of petroleum. A resinous red product was precipitated. This was isolated from the benzene-petrol mixture and was redissolved in benzene. This solution was refluxed with freshly reduced copper-gauze in order to remove the free selenium which might inhibit the crystallisation of the pure substance. The pure product was obtained after six such attempts at purification. The product was found to be a pale yellow microcrystalline powder with m. p. 191°C. Selenium as well as chlorine were found to be absent in this product. On analysis and further identification this substance was found to be mesoxanilide, (Nef, J. C. S. A., 1892, 62, 1440; Annalen, 270, 267-335). The product obtained herein combines readily with water and with alcohol to form colourless hydrate and alcohol respectively. It also combines with phenyl hydrazine in dry benzene solution. All these reactions are shown by the meso-

xanilide m. p. 190°C . obtained by Nef (loc. cit.). [Found; C, 67.06; H, 4.49; and N, 10.5; $\text{C}_{15}\text{H}_{12}\text{N}_2\text{O}_3$ requires C, 67.16; H, 4.48 and N, 10.45.

The mixed melting points of the products as prepared by Nef's (loc. cit.) method and as prepared as described herein confirms the identity of the product obtained herein.

(II) Interaction of malondiorthotolylemide with selenium oxychloride :

The reactants were taken in equimolecular quantities as in the previous case and the reaction product was obtained in exactly the same way as described above. It was obtained after purification in the form of yellowish micro-crystalline powder melting at 172°C . [Found : C, 68.85; H, 5.5; and N, 9.5; $\text{C}_{17}\text{H}_{16}\text{N}_2\text{O}_3$ requires C, 68.9 H, 5.4 and N, 9.46.]

The substance gave a hydrate on boiling with water. This hydrate was obtained in the form of colourless needles which turned yellow at 100°C , and melted at $127\text{--}130^{\circ}\text{C}$. with decomposition. It turns blue litmus red and is soluble in dilute solution of sodium carbonate.

(III) Interaction of malondiparatolylamide with selenium oxychloride.

Mesoxdiparatolylamide was prepared in exactly the same way as the corresponding ortho derivative. The pure product melted at 187°C . [Found : C, 68.8; H, 5.35; and N, 9.55; $\text{C}_{17}\text{H}_{16}\text{N}_2\text{O}_3$ requires C, 68.9; H, 5.4 and N, 9.46.]

The product when boiled with water gives a hydrate which is obtained in the form of colourless needles melting with decomposition between $122\text{--}130^{\circ}\text{C}$. Mesoxdiparatoluidide hydrate. $\text{C}(\text{OH})_2[\text{C}(\text{OH})\text{N}(\text{C}_6\text{H}_4\text{Me})_2]_2$. Melts between $120\text{--}130^{\circ}\text{C}$, (W. R. Smith, Amer. Chem., 16. 372; 393; J. C. S. A. 1894, 66, 407).

The author takes the opportunity to thank the University of Bombay and the Government of Baroda for research grants which defrayed the expenses in connection with this investigation. He is also thankful to Dr. Naik, for extending useful help from time to time.

SYNTHETIC PRODUCTION OF CAMPHOR FROM PINENE.

PART II.

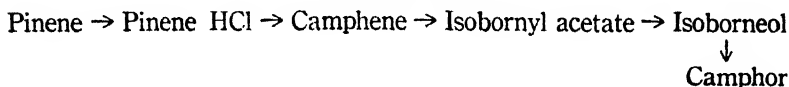
BY

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Department of Chemistry, Royal Institute of Science, Bombay.

In continuation of the work described in Part I (J. Univ. Bombay, 1934, 3, Part ii, 163), we have sought to improve the yields for various stages of the synthesis, and in addition we have investigated the recovery of the reagents. The best yields and recoveries now obtained are as follows :—

PROCESS I.



Stage.	Reagent used.	% yld. of product on reagent taken.	% yld. of product on reagent consumed.	% yld. previously reported.	Remarks.
Pinene	Pinene	80	80	80	No recovery.
↓ Pinene HCl	HCl	75	75	...	
Pinene HCl	Pinene HCl	85	85	83	No recovery.
↓	Cresol	...	...	...	3.5 mol of cresol taken per mol of pinene HCl. 86 % of the applied cresol is recovered and reused.
↓ Camphene	NaOH	37	37		No recovery.
Camphene	Camphene	82	82	80	"
↓ Isobornyl acetate.	Acetic acid.	...	...	...	250 gms. of acetic acid used per 100 gms. of camphene. 75 % of the applied acid is recovered and reused.
Isobornyl acetate.	Isobornyl acetate.	85	85	80	No recovery.
↓ Isoborneol	NaOH	34	34	...	"
Isoborneol	Isoborneol	95	95	100	"
↓ Camphor	HNO ₃	Excess of HNO ₃ originally used to act as solvent.	84	...	The oxidising solution is used repeatedly.

PROCESS II

Pinene \rightarrow Pinene hydrochloride \rightarrow Camphene \rightarrow Camphor.

(The figures are the same as in process I up to the oxidation of camphene)

Stage	Reagent used	% Yld. of product on reagent taken.	% Yld. of product on reagent consumed.	% Yld. previously reported.	Remarks.
Camphene	Camphene	50	63	50	
↓	Acetic Acid.	...	...	...	No recovery.
Camphor.	K ₂ Cr ₂ O ₇	...	...	...	*
	H ₂ SO ₄	...	...	...	*

These results give an over-all yield of 45% for process I and 43% for Process II on pinene taken. The greatest improvement has been effected in the oxidation of camphene to camphor. Particulars of the improved methods and of the recovery of reagents are given below.

EXPERIMENTAL.

Pinene \rightarrow *Pinene hydrochloride* : (Described in Part I).

Attempts to utilise the liquid by-product are in progress.

Pinene hydrochloride \rightarrow *Camphene*.

Cresol (3.5 mols : 437 gms. of which 379 gms. is obtained by recovery from a previous preparation), and caustic soda (2.3 mols : 106 gms.) are distilled up to 150°C to remove the water formed. The aqueous distillate contains 55 gms. of cresol, which is separated and used again. Pinene hydrochloride (1 mol : 200 gms.), is added to the residue and the mixture refluxed for 4-5 hours and distilled (oil-bath). The fraction up to 160° is mostly camphene (134 gms.) and is washed with aqueous caustic soda (300 gms. of 5 % NaOH) to free it from cresol, and then with water. The solid camphene thus obtained is used without further purification. Cresol (220 gms.) comes over from 160° to dryness and is used again. The solid residue is treated with dilute sulphuric acid (1000 cc. of 10 % acid) and the cresol separated (104 gms.) is used again. The total recovery of cresol is 379 gms. (86 %) and the yield of camphene is 85 % of the theoretical. The yield is 79 % on the first run, but rises in subsequent runs as the reused cresol contains camphene.

(* 3.9 mols. of sulphuric acid and 0.8 mol. of potassium dichromate are taken per mol. of camphene. They are recovered as chrome alum in 70% yield calculated on the K₂Cr₂O₇, and 58% on the H₂SO₄ taken.)

With potassium phenoxide, a 95 % yield of camphene can be obtained with 82 % recovery of phenol, but the high price of potassium hydroxide renders it unsuitable for commercial use. This gives an over-all yield of 50 % for Process I and 48 % for Process II from pinene to camphor.

A slight increase in the yield of camphene (2-3 %) is obtained by carrying out all the distillations under reduced pressure and conducting the reaction in an atmosphere of nitrogen.

Camphene→*Isobornyl acetate* :—

Camphene (100 gms.) and glacial acetic acid (250 gms.), are heated together at 45-55° for 2½ hours with a catalyst such as 50% sulphuric acid (20 gms.). Anhydrous sodium acetate (18 gms.) is then added to the reddish-coloured liquid to remove sulphuric acid, which otherwise causes decomposition during the recovery of acetic acid by distillation. Acetic acid (187.5 gms.) is distilled off (oil-bath) up to 130-35° and is used again. The residual ester (118 gms.) is washed with aqueous sodium carbonate and with water and is used without further purification. The final yield of ester is 82 % of the theoretical.

Isobornyl acetate→*Isoborneol*.

Isobornyl acetate (1 mol: 100 gms.) and 80 % aqueous caustic soda (2.5 mols: 50 gms.), are refluxed at 135-145° for 6 to 8 hours. The resulting solid isoborneol (66.5 gms.) is washed free from caustic soda. The yield is 85 % of the theoretical on the ester taken.

Isoborneol→*Camphor* :—

Isoborneol is dissolved in a mixture of five times its weight of nitric acid (35%) and one-third its weight of sulphuric acid (50%) and the solution is heated on the water bath at 75-85° for 8-10 hrs. with frequent shaking. The resulting mixture forms two layers. The upper brown layer of camphor is separated and treated with a large volume of water when camphor is precipitated and is dried and sublimed. The yield of camphor is 95% of the theoretical. Excess of nitric acid is used at the outset to act as a solvent for the isoborneol; for subsequent oxidations, the lower layer is used with addition of 70% nitric acid (66 gms. for 100 gms. of isoborneol). The yield remains constant. 25 successive oxidations were conducted using repeatedly the lower layer without any fall in the yield.

Camphene→*Camphor* :—

Camphene (1 part: 50 gms.), is dissolved in glacial acetic acid (2 parts: 100 gms.), and potassium dichromate (1.75 parts : 87.5 gms.) and sulphuric acid (2.8 parts : 140 gms.), in water (15 parts :

750 gms.) are added, and the mixture refluxed at $115-120^{\circ}$ (oil bath) for 35–45 hrs. until it becomes green and the crude floating product when sampled has m.p. above 140° . The resulting floating camphor is filtered off and washed with 5% caustic soda solution (150–200 gms. : 7.5–10 gms. NaOH) and with water. The crude product 40 gms. is subjected to fractional sublimation twice up to 110° . The sublimed camphor weighs 28 gms. ($170-172^{\circ}$) and the residue (10 gms.) of unsublimed material is mostly camphene and can be added to 40 gms. of camphene to make up the next batch of 50 gms. Accordingly 40 gms. of camphene gives 28 gms. of camphor, corresponding to a yield of 63% of the theoretical.

The filtrate is concentrated on the water bath until crystals begin to separate and it is then cooled. Chrome alum crystals separate in 70% yield on the potassium dichromate and 58% on the sulphuric acid taken.

The quantities of materials required for the preparation of 100 gms. of camphor by the two processes are as follows:—

PROCESS I.

Materials used	Taken	Consumed.	Recovered.
Pinene	200	200	
CaCl_2	4	4	
HCl	56	56	
Cresol	437	58	379
NaOH	200	200	
Acetic acid	335	84	251
CH_3COONa	24	24	
H_2SO_4	130	110	17
HNO_3	49	49	

PROCESS II.

Pinene	208	208	
CaCl_2	4	4	
HCl	58	58	
Cresol	453	63	390
NaOH	150	150	
Acetic Acid	284	284	
H_2SO_4	457	457	} 587gms. chrome alum recovered.
$\text{K}_2\text{Cr}_2\text{O}_7$	248	248	

CONCLUSION

As a result of this further work the over-all yield of pinene to camphor in process I has been raised from 42 to 45% and in process II from 33 to 43%. In the oxidation of camphene to camphor, a reaction first achieved in this research (Part I, *loc. cit.*) the yield has been increased from 50% to 63%.

The main difficulty in carrying out the process on an industrial scale now lies in the fact that Indian turpentine is unsuitable and that imported turpentine must be used. Even with the imported turpentine the yields now obtained show a possibility of economic production, and if in process II the use of acetic acid as an addition to the reaction mixture in the oxidation of camphene to camphor could be avoided the economic prospects of the production will be good.

* [It has now been found possible to avoid the use of acetic acid. The modified process is as follows: Camphene (50 gms.), $K_2Cr_2O_7$ (80 gms.), H_2SO_4 (75 gms.) and water 500 gms. are refluxed at $115-120^\circ$ (oil-bath) as before. In the first six hours 75 gms. of H_2SO_4 in 250 cc. of water is slowly added, the mixture being shaken at intervals so that the sublimed material is returned to the reaction mixture. The melting point of the final product is 1 to 2° lower than before. The yield is unchanged.]

Our best thanks are due to the University of Bombay for a grant to one of us (B. G. S. A.) towards the expenses of the chemicals.

[Received August 5, 1935]

* Note added in proof.

VISCOSITY MEASUREMENTS DURING THE COAGULATION OF TITANIUM DIOXIDE SOL BY MIXTURES OF ELECTROLYTES AND NON-ELECTROLYTES

By

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Literature abounds in data on the effect of non-electrolytes on the effective concentration of the coagulating electrolyte. But very few measurements have been made on the influence of non-electrolytes on the velocity of the coagulation caused by electrolytes. Most of the available data gives flocculation values. (vide. Freundlich, *Kapillarchemie* p. 463). The authors have emphasised in a previous communication (J. Ind. Chem. Soc., 1935, 12,552) that viscosity is a property which is very sensitive to changes in a colloidal system and that it has been utilised for the study of (i) the rate of coagulation and (ii) the degree of hydration of the colloid particles.

Ostwald (Trans. Farad. Soc., 1913, 9, 34) was perhaps the first to have recognised that additions of both electrolytes and non-electrolytes may raise or depress viscosity in the most varied manner. Rona and György (Biochem. Z., 1920, 105, 133) while studying the sedimentation of kaolin came to the conclusion that the velocity of sedimentation was markedly increased by the addition of non-electrolytes. Klosky (J. Phys. Chem., 1929, 33, 621) determined the relative viscosity of a silver sol containing different amounts of ethyl alcohol and found that it increases at first and then diminishes with an increase in the amount of alcohol. He also found that the precipitation values for the colloid are lowered by the addition of alcohol but that the calculated value of the boundary potential rises after the addition of twenty-five per cent. alcohol. Dhar (J. Ind. Chem. Soc., 1929, 6, 641) measured the viscosity of certain sols of metallic hydroxides and found that the viscosity decreases when peptising electrolytes are added. Bhatnagar and Bahl (Kolloid. Z., 1930, 50, 48) studied the effects of acetone, cane sugar and alcohol on the relative viscosity of an emulsion of olive oil and found an increase in viscosity: they concluded from the results of their experiments that the increased sensitiveness of the emulsion towards electrolytes is related to the lowering of the dielectric constant.

Prasad, Mehta and Desai (J. Phys. Chem., 1932, 36, 1391) examined the effect of methyl, ethyl and propyl alcohols on the changes in viscosity of silicic acid gel-forming mixtures with time and explained the accelerating influence of these alcohols on the rate of increase of viscosity on the assumption of the diminution of the dielectric constant of the mixture. They, however, did not explain the retarding influence of alcohols in the acidic mixtures.

It would thus appear that the influence of mixtures of electrolytes and non-electrolytes on the changes in viscosity of a sol with time has been studied only in a few cases. Moreover, the combined effect of non-electrolytes and of the purity and concentration of a sol on the changes in viscosity with time has not been studied. The present investigation deals with the influence of methyl, ethyl and propyl alcohols on the changes in viscosity with time of titanium dioxide sol dialysed and diluted to different extent when the chlorides of potassium, magnesium and aluminium are added to it.

EXPERIMENTAL

Scarpa's apparatus (Gazetta, 1910, 40, 271) modified by Farrow (J. C. S., 1912, 101, 347) and improved upon by Prasad, Mehta and Desai (J. Phys. Chem., 1932, 36, 1384) was used for the measurement of viscosity. The apparatus (fig. 1) consists of a glass vessel A having a ground glass stopper B through which two glass tubes M and N are sealed. The tube N, sealed at one end of the viscometer bulb D and the capillary tube E, is connected at the other end, to the aspirator H through the guard tube G. Glass wool soaked in a dilute solution of sodium hydroxide is placed in the guard tubes F and G to prevent carbon dioxide and dust reaching the colloid and also to avoid any change in the concentration due to evaporation. The viscometer is connected to or disconnected from the atmosphere when necessary by turning the stoppers Q and R. On opening Q the viscometer is opened to the atmosphere while R disconnects the guard tube G from the aspirator.

After the colloidal solution is put in the viscometer suction is applied to it through the aspirator. The suction produced is proportional to the difference of level of water in the aspirator H and the bottle I, both of which are identical in capacity and are connected to each other by means of a siphon arrangement K. Another siphon arrangement L connects the bottle I to the sink. It is so adjusted that within the same time, double the volume of water flowing out of H into I flows out of I into the sink. This arrangement overcomes the difficulty of pouring in or withdrawing water to ensure constant pressure, indicated by the manometer J connected to H,

The viscometer along with the guard tube F was enclosed in an electrically heated thermostat maintained at $33^{\circ}\text{C} \pm 0.02^{\circ}$. The following were the dimensions of the viscometer used:

1. Volume of the bulb between the two fixed marks..1.3838 c.cs.
2. Diameter of the capillary.....0.1095 cm.
3. Length of the capillary.....0.6566 cm.

Five c.cs. of the sol were taken in a test tube for coagulation and in another the required amount of the electrolyte + 1 c. c. alcohol diluted to five c. cs. by the addition of distilled water. The total volume of the sol + electrolyte + alcohol + water was ten c. cs. in all the experiments. This coagulating mixture was introduced into the viscometer and suction applied at 15 cms. water which was kept constant throughout the investigation. When the mixture reached the lower mark a stop watch was started and the time of rise t_1 from the lower to the upper mark was noted. The viscometer was then connected to the atmosphere and the mixture allowed to fall under its own weight: the time of fall t_2 was also noted. While mixing the sol with the alcohol and the electrolyte a second stop watch was started from which the time at which the coagulating mixture was allowed to rise and that at which it was allowed to fall in the viscometer was obtained. The mean of these times gave the interval during which the viscosity reading was taken.

The viscosity of the sol was calculated from the formula $\eta = K \left(\frac{t_1 t_2}{t_1 + t_2} \right)$ where K is a constant which was determined by finding out $\frac{t_1 t_2}{t_1 + t_2}$ for pure water whose absolute coefficient of viscosity at 33°C is known and was found to be 0.001136. The accuracy of the determination with the apparatus was tested by finding the viscosity of pure recrystallised benzene.

The sol was prepared by precipitating titanium hydroxide by adding NH_4OH to titanium tetrachloride. The precipitate was washed with hot water till free from ammonia. It was suspended in a large volume of water and boiled. At intervals, 2 N HCl was added to peptise the sol. By replacing the evaporated water from time to time, the volume of the sol was kept constant. The sol was dialysed in a parchment bag which was previously washed with hot distilled water. No titanium was detected in the dialysate during dialysis.

Twenty five c.cs. of the sol were taken, and a concentrated solution of NH_4Cl was added in excess to coagulate it. The sol was heated on a water bath at 70°C to hasten coagulation. The precipitate was washed till free from chloride. It was dried,

ignited in a silica crucible and weighed as TiO_2 . The amount of colloidal TiO_2 was found to be 2.012 grams per litre.

The electrolytes employed were the chlorides of potassium, magnesium and aluminium. Their concentrations were so selected that the time required for coagulation was about an hour except in the case of purer samples. The same concentration of the electrolytes was used in the case of the diluted sols. The non-electrolytes used were methyl, ethyl and propyl alcohols. The alcohols were kept over calcium metal, refluxed and distilled.

The original sol is designated A and the half and quarter diluted ones A/2 and A/4 respectively. All the results are not given: only a few selected ones are represented graphically in figures 2-6.

DISCUSSION.

It will be seen from the curves in figs. 2-6 that the viscosity of titanium dioxide sol to which a mixture of an electrolyte and non-electrolyte is added increases with time just as it does in the presence of electrolytes alone (cf. J. Ind. Chem. Soc., 1935, 12,552). This increase in viscosity with time is readily explained on the increased hydration of the colloid particles due to neutralization of their charge or on the supposition that it is due to the increase in size of the particles as a result of progressive coagulation.

It is to be noted, however, that the curves in figs. 2-6 are not continuous in the case of samples of the sol dialysed only for a few days. (cf. Joshi and co-workers, J. Ind. Chem. Soc., 1933, 10, 329; *ibid.*, p. 599; 1934, 11, 133). The change in the periodic nature of the curves with progress of dialysis and with dilution is given in tables 1-3 in which P, P_1 , P_2 and P_3 represent diminishing periodicity and N denotes its absence.

TABLE 1
Electrolyte KCl

Number of days for which the sol was dialysed	CH_3OH			$\text{C}_2\text{H}_5\text{OH}$			$\text{C}_3\text{H}_7\text{OH}$		
	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$
0	P	P	P	P	P	P	P	P	P_1
3	P	P	P	P	P	P	P	P	P_1
6	P	P_1	P_2	P	P_1	P_2	P_1	P_2	P_3
9	P	P_2	P_2	P	P_2	P_3	P_2	P_2	P_3
12	P	P_2	P_3	P_2	P_3	P_3	P_3	N	N
20	N	N	...	N	N	...	N	N	...
25	N	...	...	N	...	...	N	...	...

TABLE 2.
Electrolyte MgCl_2

Number of days for which the sol was dialysed	CH_3OH			$\text{C}_2\text{H}_5\text{OH}$			$\text{C}_3\text{H}_7\text{OH}$		
	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$
0	P	P	P	P	P	P_2	P	P	P_2
3	P	P	P	P	P	P_1	P	P_1	P_2
6	P	P	P_2	P	P_1	P_2	P_3	P_3	N
9	P_2	P_2	P_3	P_3	P_3	P_3	P_3	P_3	N
12	P_2	P_2	P_3	P_3	N	N	N	N	N
20	N	N	...	N	N	...	N	N	...
25	N	...	...	N	...	...	N	...	...

TABLE 3
Electrolyte AlCl_3

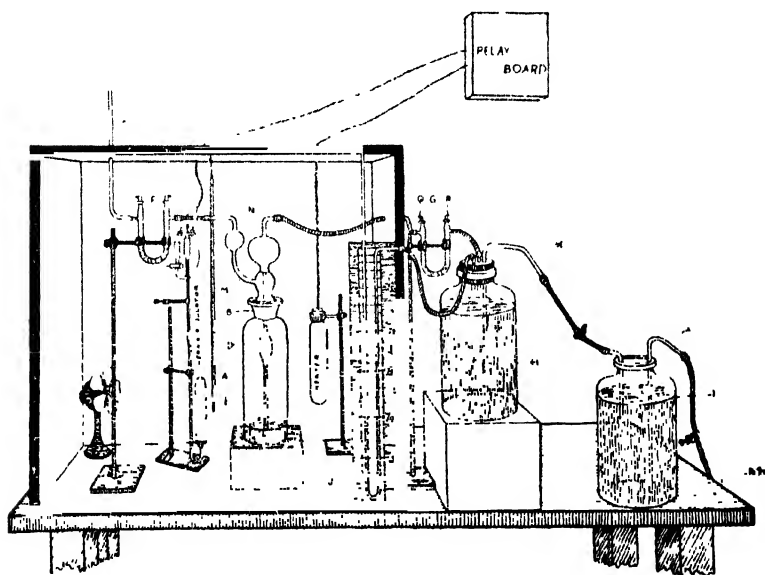
Number of days for which the sol was dialysed	CH_3OH			$\text{C}_2\text{H}_5\text{OH}$			$\text{C}_3\text{H}_7\text{OH}$		
	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$	A	$\frac{A}{2}$	$\frac{A}{4}$
3	P	P_2	P_3	P	P_2	P_3	P_1	P_3	P_3
6	P	P_2	P_3	P_3	P_3	N	N	N	N
9	P_2	P_3	P_3	P_3	P_3	N	N	N	N
15	N	N	N	N	N	N	N	N	N
20	N	...	...	N	N	...	N	...	...
25	N	...	...	N	...	...	N	...	...

It would appear from the above that the purity of the sol plays an important part in conditioning the periodic nature of the viscosity time curves—a conclusion which is in accord with the observations made in the case of coagulation of titanium di-oxide sol by electrolytes alone. Since the concentrations of the coagulating electrolytes were so chosen that complete coagulation took place in about an hour except in the case of purer samples of the sol it is obvious that the curves are periodic in nature only in the slow region of coagulation. It is to be observed that the periodic nature of the curves tends to disappear as the sol gets purer and therefore with a very pure sample of the sol it is not possible to realize experimentally the discontinuous change in viscosity with time.

On a comparison of the viscosity time curves obtained in the presence of non-electrolytes with those in their absence it will be seen that the viscosity of various samples increases by the addition of the

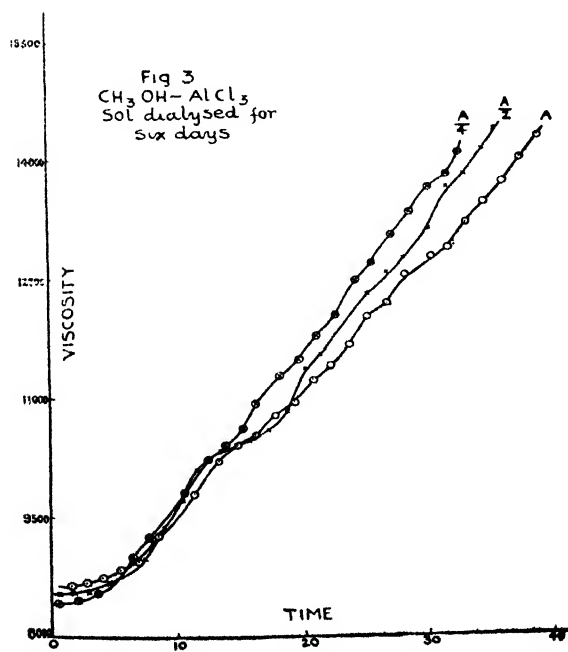
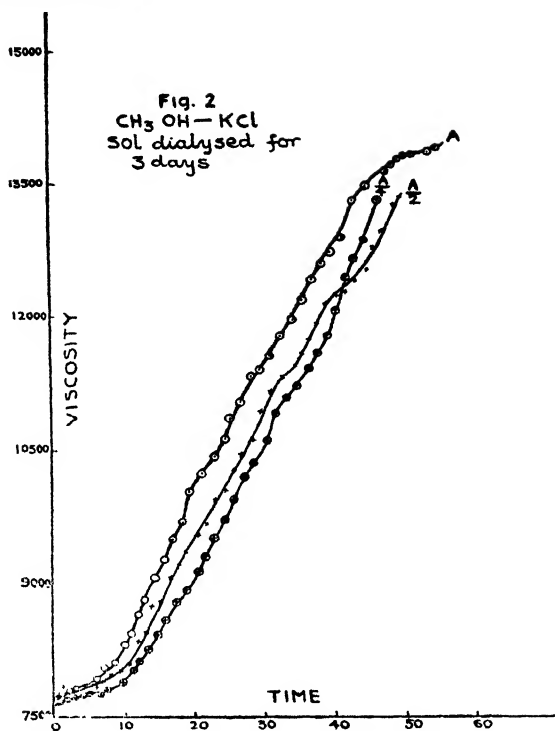
alcohols. This observation seems to be in agreement with the view that the addition of alcohols to a colloidal solution diminishes the dielectric constant of the medium with a consequent decrease in density of charge on the particles and an increase in their hydration. (cf. Freundlich, *Kapillarchemie* 1922, 637; Dhar, *J. Phys. Chem.* 1926, 30, 1646). It is also found that the rate of coagulation is greater in the presence of electrolytes+non-electrolytes than in the presence of electrolytes alone. This shows that not only an initial change takes place in the condition of the colloid particles on the addition of non-electrolytes but even subsequently either the rate of aggregation of the particles or their rate of hydration or both increase.

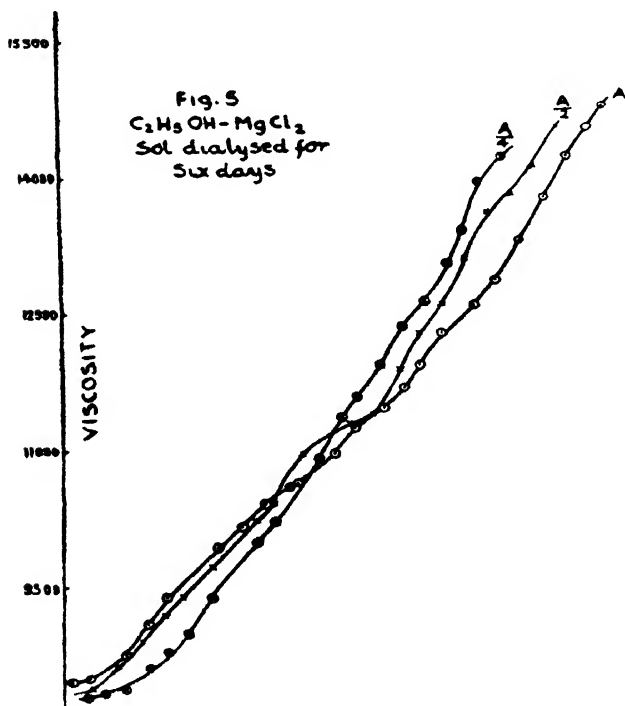
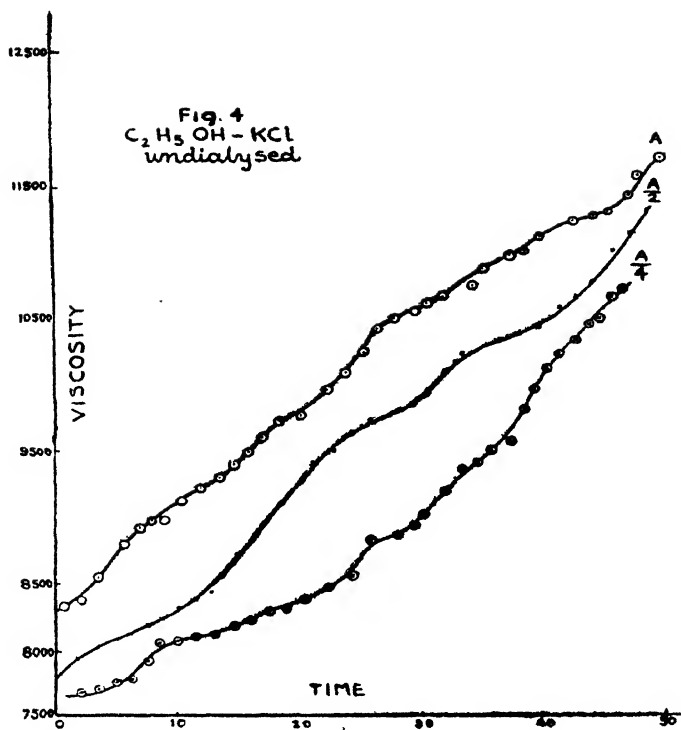
The authors are thankful to Dr. Mata Prasad for useful suggestions and help.

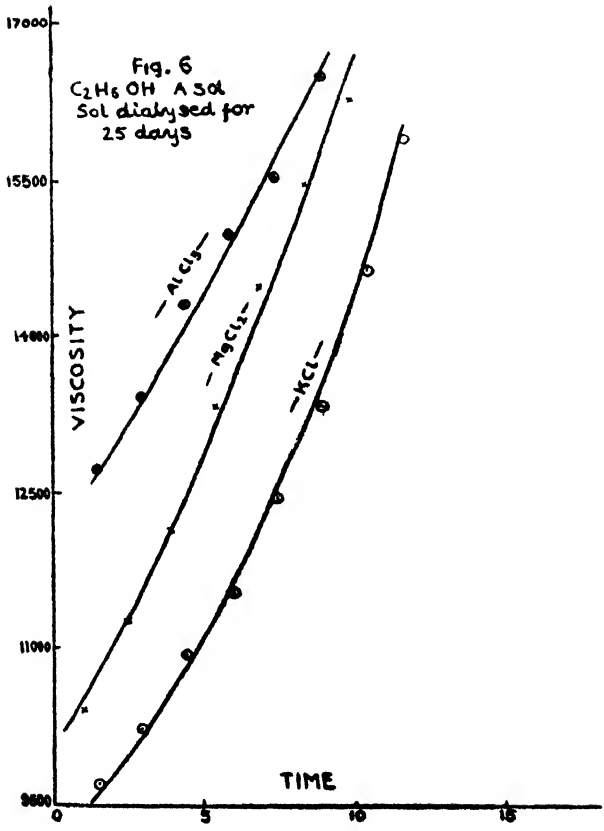


(Figure 1)

Transaction No. 16; Viscosity measurements during the coagulation of titanium dioxide sol by mixtures of electrolytes and non-electrolytes by Miss. Olive Joseph and Mr. S. M. Mehta.







THE METHODS OF MEASURING SURFACE TENSION

BY

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Several phenomena which a liquid surface exhibits form the basis of different methods employed for the determination of surface tension. Adam (Physics and Chemistry of Surfaces 1931) has classified these methods into (1) static and (2) dynamic. Fergusson (Science Progress, 9, 428, 1915) classified them into two divisions: (1) those which depend upon and (2) those which are independent of contact angle. In what follows, these methods have been reviewed in brief and the main theoretical and experimental difficulties involved in using them for determining the surface tension of liquids have been pointed out. A method developed by Fergusson (Proc. Phys. Soc., 44, 511, 1932) and improved upon by the authors is described in this paper and the results obtained for standard liquids have been compared with those obtained by previous workers.

Conditions which should necessarily be fulfilled by any method which can be used for the correct determination of surface tension are: (1) it must give results of a high degree of accuracy in a reasonable time; (2) it must be amenable to a perfect and easy temperature control and (3) it should be unimpeachable in its mathematical details.

Of the two types of methods mentioned by Fergusson, the capillary rise method is the most important of those which depend upon the contact angle. The formula deduced for the calculation of the surface tension by this method involves the height 'h', to which a liquid rises in a capillary tube of uniform bore "r", the density of the liquid 'd' and the contact angle ' θ '. It is thus essential in this method that capillary tubes of uniform bore should be used. Now it is not only difficult to have capillary tubes of uniform bore but different results are obtained when tubes of different diameters are used. However, Sugden (J. C. S., 1483 1921,) has constructed a table by means of which the best observations made by this method with tubes of any diameter can be corrected. Further, the variation in the height of the liquid column in a capillary tube due to a change in the surface tension of a liquid with temperature cannot be accurately ascertained, because the expansion of the liquid and the lowering of

the surface tension due to increase in temperature act in opposite directions. Also the contact angle is assumed to be zero or almost zero when a liquid 'wets the glass'—a term which is not correctly defined and is not clearly understood. There are other defects in this method, such as the difficulty in the cleaning and drying of the narrow capillary tube, controlling temperature etc.

Methods which do not depend upon contact angle have been divided by Fergusson (*loc. cit.*) into four different groups: (1) vibration methods, (2) the balance method, (3) methods depending on bubbles and drops and (4) the capillary tube method. The different methods belonging to each of these groups, have been discussed by him in sufficient details. Below are mentioned only the salient points regarding the above-named methods and of others which have later come into use.

Methods which depend upon the oscillation of drops and jets (cf. Rayleigh: *Proc. Roy. Soc.*, 29, 71, 1879; Bohr: *Phil. Trans.*, A, 209, 281, 1901; and Stocker: *Z. physikal. chem.*, 94, 149, 1920) and on the formation of ripples on the surface of liquids are fairly complex. They involve the measurement of the period of oscillation of small falling drops about their equilibrium figures, the measurement of the wave-length of the waves formed on the surface of jets of liquids and of ripples generated on liquid surfaces. Lord Rayleigh's theory of the former method has been supplemented by various correction factors by Bohr (*loc. cit.*) who has also devised an experimental technique which satisfies the theoretical assumptions. If all the measurements involved in these methods are not made with extreme care, the results obtained will be erroneous.

The second group of Fergusson's classification includes methods which involve the measurement of (i) the pull required to detach a ring from the surface of a liquid and (ii) the tension in a film of a liquid formed on a light frame. The accuracy of the former method depends upon the dimensions of the ring and on the thickness of the wire of which it is made. But the formulæ used for calculating the surface tension are only approximate and the results obtained are in error. Du Nöuy (*J. Gen. Physiol.*, 1, 521, 1919) has designed a convenient form of an apparatus depending upon the above mentioned principles but this yields results which are only reliable within one per cent. provided a fairly large number of precautions are taken. The second method is based on the same principles as the former, but its application is very restricted as many liquids do not form permanently stable films.

The bubble and drop methods require the measurement of excess of pressure in a hanging drop or a bubble or in a drop formed

on or underneath a glass plate and the radius of curvature of the drop or of the bubble. These methods may give results of sufficient accuracy under suitable conditions but it is not easy to measure the radius of the drop or of the bubble with great exactness. Further in the case of bubbles formed on a plate the equation correlating the surface tension of the liquid with the measurements which can be made on the bubbles is not correctly known.

The method due to Jaeger (Z. Anorg. Chem., 101, 1, 1917) is the most important of those included in the capillary tube methods. It is based on the measurement of the pressure required to release a bubble from the end of a capillary tube dipping vertically in a liquid. The formula deduced for the method is based on statical principles which require that the rate of bubbling should be exceedingly slow. Further it is essential to determine the depth of the lower end of the capillary below the surface of the outside liquid which should be contained in a fairly wide vessel.

These complications are avoided in a simple apparatus devised by Sugden (J. C. S., 125, 27, 1924) by means of which very accurate results can be obtained fairly rapidly with small volumes of liquids.

The drop-weight method (J. A. C. S. 30, 1908) which has also been used for surface tension determination is based on Tate's (Phil. Mag., 27, 176, 1864) suggestion that the weight of a drop is proportional to the radius of the tube from which it falls. However, in practice, not the whole drop, but only a part of it is collected, the rest remains sticking to the tube. This has been demonstrated by Guye and Parrot (Arch. Sc. Phys. Nat. 15, 178, 1903) from a cinematographic study of a falling drop. Harkins and Brown (J. A. C. S., 41, 499, 1919) have attempted to fill up the gap between the theory and practice of this method by laborious standardisations and by the use of correction tables but their improvements are negated because of the doubtful assumption that the fraction of a falling drop of similar shape is the same for all liquids, and that the surface tension of the standard liquid determined by one or the other methods is correct.

In all the methods excepting Sugden's described so far a fairly large amount of a liquid is required for the surface tension determination. Kiplinger (J. A. C. S., 42 472, 1920) devised a method in which only a small amount of the liquid is needed. A thread of a liquid in a capillary tube open at both ends is inclined till the meniscus at its lower end is plane. The surface tension is calculated from the formulæ.

$$T = \frac{rdl g \cos \alpha}{2}$$

where α is the inclination of the capillary to the vertical.

Fergusson (Proc. Phys. Soc., 36, 1923) has developed a method in which quantities of liquids required are much smaller than those in Kiplinger's method. The method depends upon measuring the pressure which will bring the meniscus of a liquid at the lower end of a vertical capillary in a plane position. The surface tension calculations involve a knowledge of the densities of the liquids used in the capillary and that used in the manometer. The determination of the density of the liquid is impossible if the available quantity of the liquid is very small. Fergusson (Proc. Phys. Soc., 44, 511, 1932) later found that if the capillary is placed in the horizontal position and be of a diameter less than one millimeter, then density measurements are no longer required. The surface tension is given by

$$T = \frac{1}{2} h d r g$$

where h and d refer to the manometric liquid and r is the radius of the end of the capillary.

The pressure on the inner side of the thread of liquid in the capillary is increased by forcing air by means of an aspirator which can be raised to any desired position by rack and pinion screw. This arrangement gives jerks to the entire apparatus and the plane position of the meniscus does not remain steady for sufficient time. Also the capillary tube has to be fused to the manometer tube for each observation. This involves a considerable waste of time particularly when a large number of observations are to be taken. Further the results are erroneous because the manometer is not kept at a constant temperature due to which the density of the manometer liquid changes. If the method is employed for determining the surface tension of solutions, the cross-section of the capillary bore being small, the heating effect of the rays of light focussed for observing the plane position of meniscus will increase the concentration of the solution at the surface. These defects in Fergusson's method have been removed by the following alterations:—

(1) The two vessels used for adjusting the pressure have been substituted by a simple mechanical device.

(2) The capillary tube has been kept in an air-thermostat and the manometer in a water bath kept at a constant temperature. The accuracy of the results is further increased by the use of xylene (sp. gr. 0.8576) as a manometric liquid.

(3) The capillary tube has been connected to the tube leading to the manometer by means of an air-tight ground glass joint.

(4) A large flask containing water at constant temperature has been interposed in the path of the beam of light illuminating the end of the capillary.

Description of the apparatus

The apparatus used is shown in Fig. 1. It mainly consists of a horizontal capillary tube C, which is connected by a ground glass joint (fig. 1a), to the tube leading to the manometer M. The portion of the tube from C to K which is sufficiently long, is kept in an air thermostat maintained at a constant temperature. E (Fig. 1a) is a round bottomed flask containing the solution under investigation and fitting loosely to the tube C. A bulb D is fused to the tube from the manometer, through a capillary PQ and is connected by a pressure tubing to a mercury reservoir H capable of being raised or lowered by a mechanical arrangement of worm and worm wheels. B-B are water baths maintained at 30°C., the temperature at which the density of the manometric liquid was determined.

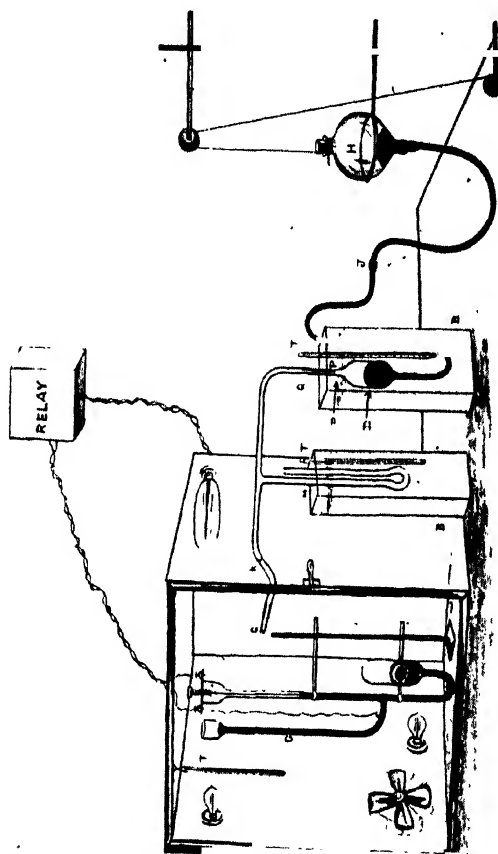
METHOD

The capillary tube was about 5 cms. long and the mean value of the diameter of its bore determined from twenty different measurements was found to be 0.0545 cm.

The capillary tube was first cleaned by means of hot chromic acid, sodium hydroxide solution and distilled water and was finally dried in a current of hot air. Approximately one cm. length of the solution was taken in the capillary which was afterwards attached to K through the ground glass joint. The atmosphere in the air thermostat was kept saturated with water vapour to prevent evaporation from the surface of the solution in the capillary tube by means of four evaporating dishes containing the same solution as under investigation.

The end of the capillary was illuminated by a milky electric bulb focussed on it by a lens. In the path of light was interposed a flask containing water maintained at constant temperature. The illuminated end of the capillary tube was focussed in the field of a long focus microscope. While viewing the bore of the capillary, which appeared as a dark circle through the microscope, the handle A was gradually turned, so as to change the pressure on the meniscus. When the pressure attains a certain value, a tiny bright spot (fig. 1b, i) appears in the dark circle in the field of view, which gradually increases in size (fig 1b ii) as the pressure increases. Finally at a critical pressure the meniscus becomes perfectly plane and the whole of the initial dark circle becomes illuminated (fig. 1b, iii). Further increase in pressure results in the diminution of this white circle due to formation of convex surface (fig. 1b, iv, v). The condition of the complete illumination of the initial dark circle in the field of view indicating plane surface of the meniscus was extremely critical as the slightest variation in the pressure at once indicated a change in the surface. Also the pressure required for this condition

Fig. 1.



(Figure 1)

Transaction No. 17: The Methods of measuring Surface tension by Messrs. C. C. Patel,
K. V. Desai and S. M. Mehta.

could be maintained constant for nearly an hour. The pressure corresponding to the formation of plane surface of the meniscus was observed in the manometer by means of a travelling microscope reading accurately to the third place of decimal. Mean of several observations was taken as the true manometric height.

COMPARISON OF RESULTS.

In table, I, the values of surface tension obtained for water and benzene at two temperatures 15°C and 30°C by the above method are given along with those obtained by other workers. Table II gives the results for CaCl₂ solutions along with those of Livingston, Morgan and Schramm (J. A. C. S., 35, 1848, 1913)

TABLE I.

Surface tension of water and benzene in dynes/cm.

Investigator	Method	Water		Benzene	
		15°	30°	15°	30°
Volkman	Capillary rise Method	73.26	...	29.51	...
Domke	"	...	71.04	...	...
Harkins and Brown	"	73.55	...	29.59	...
Richard and Caster	"	...	71.32	29.61	...
Ramsay and Aston	"	...	...	28.68	...
Harkins and Brown	Waves on jet	73.38	...	...	...
Harkins and Ching	Drop weight	...	...	...	27.61
Morgan	"	...	71.03	...	...
Dorsey	Waves on jet	73.76	...	...	...
Sentis	Ripples	73.45	...	...	...
Richard and Combs	"	74.30	...	...	...
Fergusson	Jaeger's method	72.78	...	29.65	...
"	* Method (vertical capillary)	73.88	...	29.20	27.00
"	Pressure to make meniscus plane (Horizontal capillary)	73.47	...	29.14	...
Critical Tables	(International)	...	71.18	...	27.56
Author	Present method	73.52	71.21	29.57	27.59

* Pressure to make meniscus plane (vertical capillary).

TABLE II.

Values of Surface tension of CaCl_2 solutions compared.

Concentration in gm. mols per 1000 gms. of water	* Livingston, R. Morgan and Schramm. Drop weight method.	Authors.
0.0	71.03	71.21
0.5	71.91	72.23
1.0	72.20	72.81
1.5	73.36	73.55
2.0	74.52	74.32
2.5	75.56	75.31
3.0	76.04	76.45
3.5	78.64	77.60
4.0	78.81	78.78
4.5	80.21	80.15
5.0	82.91	81.64
5.5	83.91	83.03
6.0	85.12	84.47
6.5	87.13	86.20
7.0	89.23	87.98
7.5	91.92	89.86
8.0	92.65	92.54
8.5	95.79	95.40
9.0	97.12	98.81

From the various improvements suggested in this paper the authors consider that their values are more accurate than those so far obtained by Fergusson's method. This conclusion is further supported by the fact that the values of surface tension for different solutions of calcium chloride obtained by the authors lie much closer to a smooth curve than those of Livingston, Morgan and Schramm (cf., Fig. 2).

The authors are indebted to Dr. Mata Prasad for useful suggestions which led to the use of the present improved method for determining surface tension.

* J. A. C. S., 35, 1848, 1913.

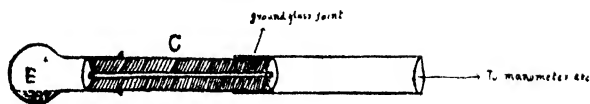


Fig 1a.

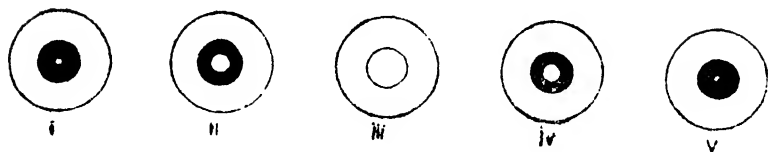


Fig 1b.

Figs. 1 a & 1 b

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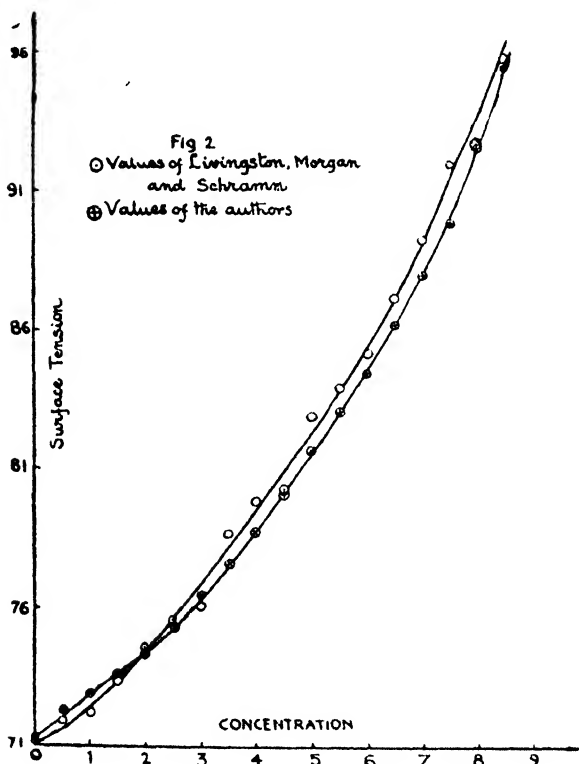


Fig. 3

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COAGULATION OF DILUTE OIL EMULSIONS BY MERCURIC CHLORIDE: EVIDENCE FOR THE DISCONTINUITY OF THE CHANGE IN THE SLOW REGION.

BY

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The problem of the formation and the stability of emulsions has been investigated by numerous workers from the standpoint of theory and industrial practice. One of the principal findings in this field is the importance of the data for the viscosity of the medium (Wilson, *Phil. Mag.*, 1883, 15, 406; Hillyer, *J. Amer. Chem. Soc.*, 1903, 25, 513; Marshal, *Pharm. Journ.*, 1909, 28, 264; Sanyal and Joshi, *J. Phys. Chem.*, 1922, 26, 481). It was observed by one of us (Joshi, *Trans. Farad. Soc.*, 1925, 20, 512-19) in a study of reversible emulsions that with a knowledge of this quantity, the progress of the transformation of the emulsion from one type to the other, by a mere alteration of the volume ratio of the two phases could be followed with ease and accuracy. It is known that such reversals can also be effected by the introduction of appropriate electrolytes (Clowes, *J. Phys. Chem.*, 1916, 20, 407-51; Bhatnagar, *J. Chem. Soc.*, 1921, 119, 61-8; Parsons and Wilson, *J. Ind. Eng. Chem.*, 1921, 13, 1116-23), and that analogy exists between the type reversal of an emulsion and the coagulation of a sol (Clowes, *loc. cit.* 1916, 20, 445; Bhatnagar, *Trans. Farad. Soc.*, *Symposium on Colloids*, 1920; Joshi, *loc. cit.*). Whilst a considerable mass of information is available about the coagulation kinetics of sols in the *rapid* and the *slow* region of coagulation, barring a very few exceptions (Bhatnagar, *J. Phys. Chem.*, 1921, 16, 735; Ellis, *Trans. Farad. Soc.*, 1913, 9, 14) corresponding data for emulsions are not available in the literature. In previous communications from these Laboratories (Joshi and Viswanath, *J. Indian Chem. Soc.*, 1933, 10, 329-340; Joshi and Menon, *ibid*, 1933, 10, 599-609; Joshi and Nanjappa, *ibid*, 1934, 11, 133-143; Joshi and Iyengar, *ibid*, 1934, 11, 555-571; 573-577; Joshi and Pannikar, *ibid*, 1934, 11, 797-804), it has been shown that the process of the *slow* coagulation of a number of sols produced by variously concentrated solutions of different electrolytes, and by oppositely charged sols is not continuous with respect to the coagulation time. Since this conclusion constitutes a departure from the

current theories of the kinetics of coagulation, it was of interest to examine it for the *slow* coagulation of a different class of colloids, *viz.* emulsions.

Evidence has been presented previously (*loc. cit.*) that any one of the familiar properties used to measure the degree of coagulation is restricted in the range of its applicability. In the following experiments, therefore, completer information was sought by employing three independent methods in order to follow the progress of a coagulation, *viz.*, viscosity, transparency and refractive index. With the exception of a communication to the Chemistry Section of the *Proc Ind. Sci. Congress* 1934, from these Laboratories, the use of variation in the last mentioned property as a measure of coagulation does not appear to have been recorded in the literature of the subject. The application of this method, studied in numerous cases in these Laboratories, has revealed the presence of factors which were not noticed in results with earlier methods of measuring coagulation.

EXPERIMENTAL.

The emulsions were prepared by the precipitation method as developed previously (Joshi, *Koll. Zeit.*, 1923, 34, 197-201). Briefly, about 1.5 c.c. of the purest available sample of the oil to be emulsified was dissolved in a small amount of absolute alcohol. This solution was then poured in about a litre of twice distilled water which was almost boiling hot. After vigorous shaking, a fine, bluish grey emulsion, uniformly dispersed, was obtained. Free alcohol was removed by boiling off carefully. It was then passed through a double filter paper of close texture and stocked in Jena glass bottles. Thus prepared the emulsions are very stable, except for 'creaming' which depends principally on the difference in the specific gravities of the two component liquids. This, however, is a very slow process and is practically negligible. By far the majority of experiments reported here were made with emulsions from the *Til* oil. Emulsions used in experiments to which the viscosity-time curves Nos. 10, 11 in fig. 2 refer, were made with mustard oil.

The viscosity was measured by Scarpa's method (*Gazetta*, 1910, 40. 271; *cf.* also Farrow, *J. Chem. Soc.*, 1912, 101, 347) with modifications described previously (Joshi and Menon, *loc. cit.*). Using a small capillary with a bulb at one end, the method requires but a knowledge of t_1 , the time of rise of a small amount of the liquid to be studied under constant suction, and t_2 , the time for fall under its own hydrostatic pressure. No knowledge of the density of the liquid is required, which is a great advantage. The suction applied was kept constant at 25 ± 0.05 cm., water, the observations being made with a low

power telescope. The temperature of the thermostat was $35 \pm 0.1^\circ\text{C}$. Equal volumes of the emulsion and of the electrolyte solution of the required strength were allowed to attain the temperature of the thermostat. The coagulation was started by mixing the liquids in the Scarpa tube V (*cf.* fig. A, Joshi and Viswanath, *loc. cit.*). The viscosity of the mixture was then measured at convenient intervals for about four hours; in a few cases the observations were continued to about 24–48 hours after the start of the coagulation. In all the coagulations studied previously (*loc. cit.*) viscosity measurements were continued till the coagulating sol in the capillary or the bulb of the viscometer showed the least traces of flocculi. This was not possible in the present work despite special arrangements made and precautions taken for the observation of any heterogeneities produced during coagulation. This was at least partly due to the relative optical characteristics of the oils emulsified and water. η , the viscosity was calculated from the formula, $\eta = K \frac{t_1}{t_1 + t_2}$, where K is a

constant. The value of K was calculated from t_1, t_2 measurements made with a standard liquid like water for which η is known to be 0.7225 C. P.; the results are therefore in absolute centipoise units. The degree of the reproducibility of results using pure liquids was found to be at least 3–4 in 1000. Variations less than at least 4 times this value were not considered. These results are shown graphically in figs. 1-2. In order to economise space and also to prevent curves from coalescing, the scale units and the position of the origin were varied in a group of related curves, and have been indicated in figures.

Measurements of the transparency during coagulation were made by the use of a sensitive thermopile and a low resistance Broca galvanometer. Light from a 4-volt lamp run at a constant potential from a battery of storage cells was first passed through a column of distilled water in order to cut out the heat radiation, and then allowed to fall on the optical cell which contained the coagulating mixture. Intensity of the light transmitted by the sol was indicated by the deflections of the galvanometer. The source of light, the water filter, the coagulating sol and the thermopile were enclosed in an air thermostat with glass sides. This was immersed in water in another thermostat, except on the top which was closed by a well fitting cover insulated against heat conduction by thick pads of sheep wool. The outer thermostat was also well protected by pads of wool except on the glass faces which were well screened to cut off stray light. The temperature of this thermostat was kept constant at $32.6 \pm 0.2^\circ\text{C}$. Under these conditions the thermopile was found to be well protected against external radiation and changes of temperature. In order to

compare coagulations with mercuric chloride with other coagulants, typical curves with dilute solutions of cadmium chloride and sulphuric acid are also given. These results for the transparency are shown by time-deflection curves in fig. 3.

The refractivity measurements were made with the Pulfrich refractometer. By means of water circulation from a thermostat the temperature of the glass cell in the refractometer which contained the liquid to be examined was brought to 34°C. From samples of the emulsion and of the solution of the coagulating electrolyte, which were also preheated to $34^{\circ} \pm 1^{\circ}\text{C}$, exactly one c. c. of the emulsion and then an equal amount of the coagulant were introduced carefully in the refractometer cell, and the mean time of addition noted. Measurements were continued till the readings became constant. Curves 1-7 in fig.4 relate μ , the refractive index with the coagulation time. Three stocks of *Til* oil emulsion A, B, C were used with approximately the same oil content. Curves 1-6 in figs.1 & 2, curves 7, 8 in fig.2, and curve 9 in fig.2 and all curves in figs.3 and 4, refer to experiments made with stocks A, B, C respectively. Curves 10 & 11 in fig.2 refer to mustard oil.

DISCUSSION OF RESULTS.

An examination of the viscosity-time curves in figs. 1 and 2 confirms the conclusion drawn previously from the coagulation data of a number of sols by a variety of coagulants (*loc. cit.*) that the progress of coagulation, in so far as change of viscosity is a measure of the corresponding degree of coagulation produced, is not continuous with coagulation time, and that the occurrence of breaks or discontinuities tends to be more pronounced the lower the concentration of the electrolyte. It is also seen that in the majority of coagulations studied (*cf.* figs. 1,2) and in agreement with earlier results (*loc. cit.*) that the course of coagulation is marked by an initial diminution of viscosity variable in the range 0.6 to 2 per cent of the initial viscosity. Small alterations in the concentration of a coagulator are known to have a marked effect on the time required for attaining a given stage of coagulation (*cf.* Joshi and Viswanath, *loc. cit.*). This is also to be anticipated from Paine's exponential relation relating the coagulation velocity and the electrolyte concentration (*Koll. Chem. Beih.*, 1912, 16, 430); it is interesting therefore, to note that the time corresponding to the occurrence of this initial diminution of viscosity varies irregularly in the range 20 to 30 minutes after the start of the coagulation despite appreciable variations in the concentration of the coagulator. These results are similar to those obtained previously with *hydrophobes* (*cf.* Joshi and Viswanath, Joshi and Iyengar, *loc. cit.*) and are in agreement with the suggestion made earlier (Joshi and

Pannikar, *loc. cit.*) that the period corresponding to the initial diminution of viscosity might not be a stage in the main process of coagulation, envisaged as a continuous coalescence of particles into aggregates of increasing size. It might be mentioned incidentally, that this is the main mechanism implied in Smoluchowski's theory of the kinetics of coagulation (*Z. Phys. Chem.*, 1917, 92, 129).

It has been in general tacitly assumed by colloid chemists that coagulation necessarily produces a *nett* rise in the viscosity. That this is by no means always true is shown by curves Nos. 2, 3, 4 in fig. 1 and curve No. 6 in fig. 2. The last shows a definite and a marked *diminution* of viscosity below the initial value as a result of the coagulation. Very definite instances of an overall and appreciable decrease in viscosity consequent upon coagulation of lyophobic colloids were observed earlier (Joshi and Nanjappa, Joshi and Iyengar Joshi and Pannikar, *loc. cit.*). It is probable that the occurrence of the initial diminution of viscosity mentioned already and the overall decrease in viscosity due to coagulation might result, in part, from the operation of the same factors. While more detailed and wider based experimental results are necessary for their satisfactory elucidation, the generality of the above findings is a clear evidence of the theoretical deficiency in the present position of the viscosity of colloids.

Results shown by curves in fig. 3 show a diminution of transparency during coagulation, which is to be anticipated on general grounds. With the exception of curve 3, it is seen that, the change is rapid in the initial stages and almost comes to a standstill during later stages. From a general comparison of this last mentioned period with the corresponding sections of the viscosity-time curves, which almost as a rule are characterised by discontinuities, the possibility is suggested that transparency measurements might not be susceptible to changes revealed by a typical colloid sensitive property like viscosity. Some observations of the transparency and the viscosity measurements of a number of protected colloids subjected to coagulation studied in these Laboratories (Joshi and Joga Rao, *J. Indian Chem. Soc.*, 1933, 10, 247) were amongst the earliest evidences in this line.

An examination of results in fig. 4 shows that the refractive index of a coagulating sol diminishes during coagulation in all the cases and this tendency is greater the greater the concentration of the coagulator. It is interesting to see from these curves that the above change occurs through stages during some of which the refractivity remains sensibly constant. It would also appear that the number of such stages tends to increase as the electrolyte concentration is

Fig. 1
Variation of Viscosity during Coagulation

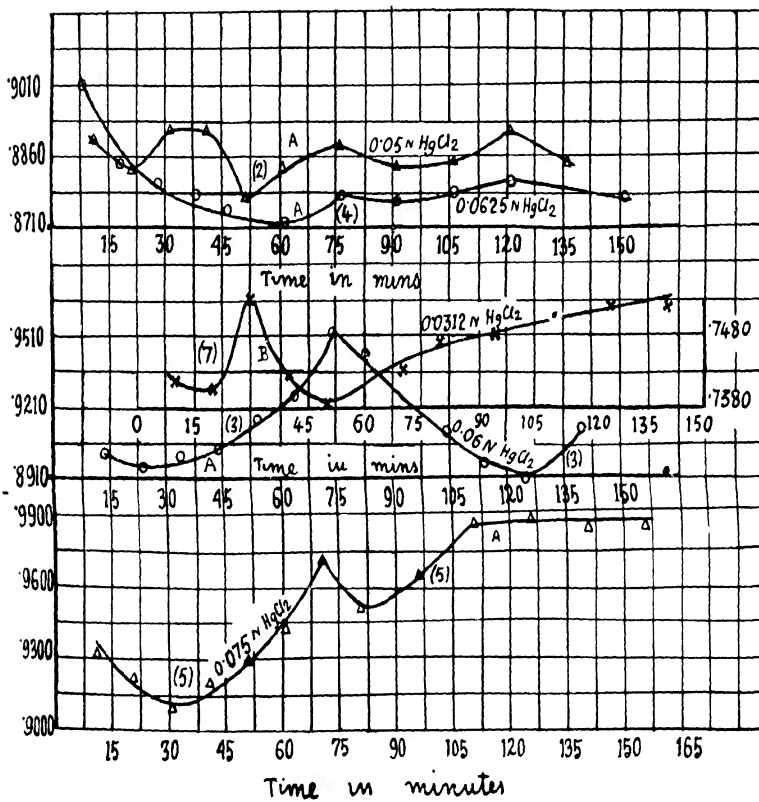


Fig. 2

Variation of Viscosity during Coagulation

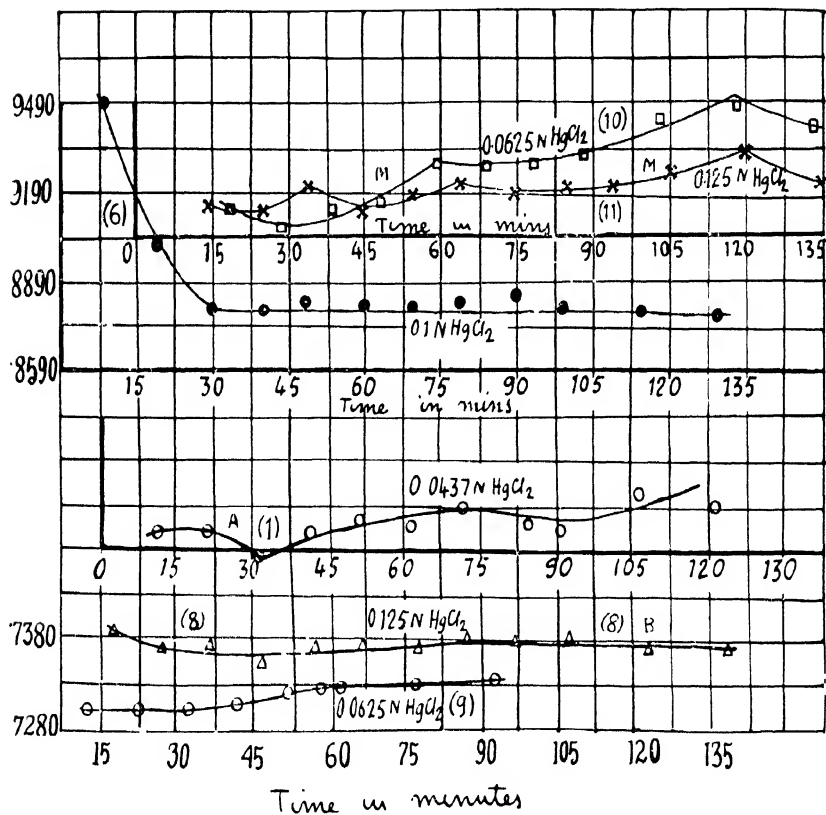


Fig. 3(c)
The Variation of Transparency
during Coagulation

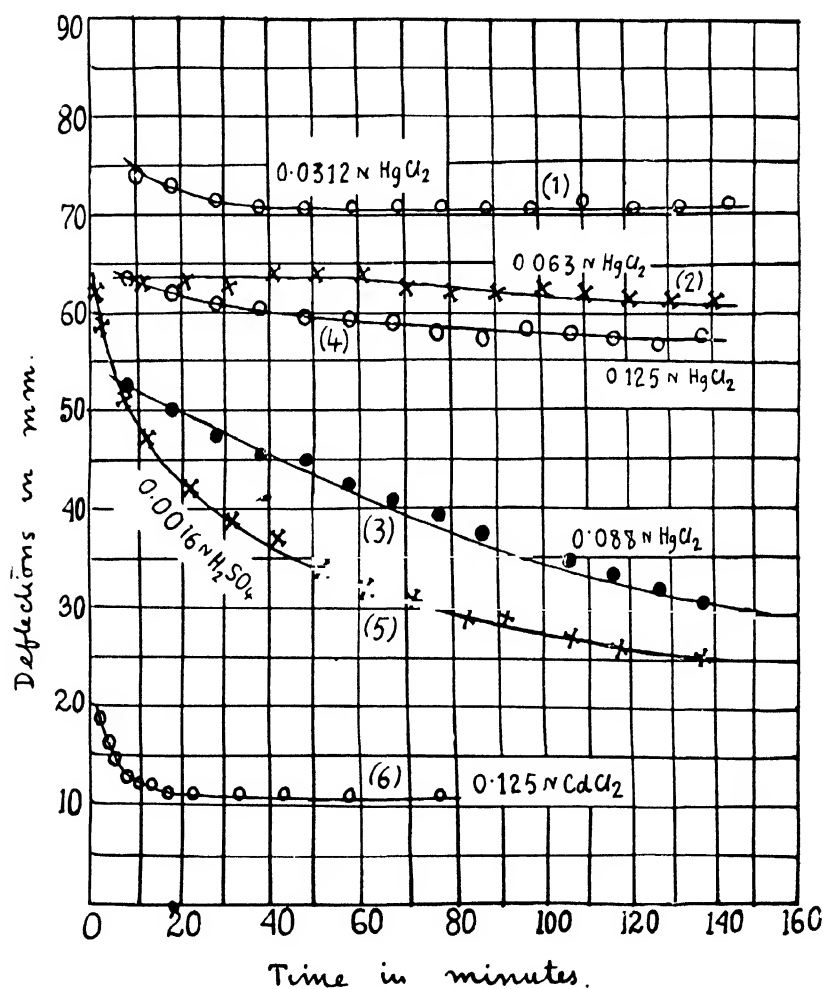
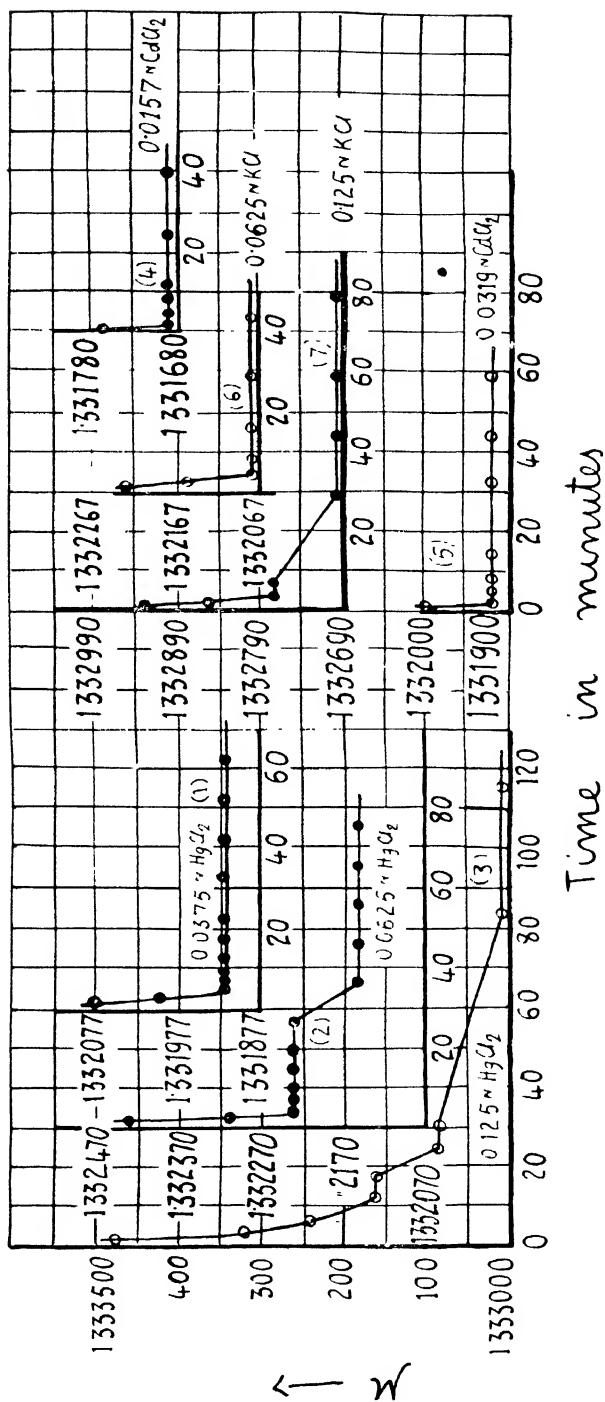


Fig 4 (c)

Variation of Refractivity during Coagulation.



increased. Despite notable contributions to the subject (Rayleigh, *Phil. Mag.*, 1871, 41, 107 ; 1899, 47, 375, *et seq* ; Garnett, *Phil. Trans.*, 1904, (A) 203 385 ; 1906, 237 ; Mie, *Koll. Zeit.*, 1907, 129 ; *Ann. der Phys.*, 1908, 25, 337 ; Lampa, *Akad. Wiss. Wien. Sitz. Ber.* 1909, 118, 867-83), the prevalent theories of the optics of the colloid state do not yet allow of an *a priori* analysis of the refractivity of a coagulating sol in terms of the composition of the system ; the refractive index of the coagulating material, the dispersion medium and of the dispersed phase ; the micellar charge ; the size, (shape) and the number of the particles per unit volume, and so forth. Changes in the last named factors produced during coagulation alter the magnitude of the total optical path which a ray of light traverses in unit time in the system and therefore its overall refractivity. It is anticipated therefore that the refractivity of the system should, during the process of coagulation, approximate to that of the continuous medium modified by the presence of the coagulant. The results obtained are in agreement with this deduction only partially, since size and the number of particles per unit volume are not the only determinants of the refractivity of the system, liable to change during coagulation. The remarkable result that in at least a definite number of cases the refractivity remains constant for a period, and then changes *discontinuously* to a new value also characterised by a similar constancy for a time, and so on throughout the progress of coagulation, observed for the first time in these Laboratories, not only supports the view developed previously that coagulation constitutes a complex 'succession of micellar and allied changes in the dispersion medium, but also that the property selected for measuring coagulation might not be sensitive at a given stage to some or all of the above changes constituting coagulation. If for instance, this happens during the initial stages of coagulation, the so called S-shape in the corresponding coagulation-time curve would result, and give but a spurious evidence of *autocatalysis*. It would certainly be of interest from the standpoint of a comprehensive theory of coagulation to investigate if the occurrence of discontinuities, each marked by a constant value of the refractivity is a *general* phenomenon. That it is certainly very widely occurrent, though hitherto unrecognised, is almost a foregone conclusion from data accumulated already in these Laboratories from observations of over sixty cases.

CHEMICAL INVESTIGATION OF THE SEEDS OF HYGROPHYLA SPINOSA.

BY

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Hygrophyla Spinosa is a herb abundant throughout India. It is very common in the Konkan. It belongs to the natural order Acanthaceae. The vernacular names are :—

Kokilaksha, or Ikshugandha, (Sanskrit).; Talimkhana, (Hindi); Niramalli, (Tamil); Kuliamera, (Bengali) Ekharo (Gujarathi); Kolsundara, (Marathi).

It is an annual marshy herb having bright purple flowers. The seeds are small, flattish and brown in colour, like the eyes of Indian Cuckoo from which it derives its sanskrit name Kokilaksha. The roots and the seeds are widely used in Indian medicine. The root is considered cooling, bitter, tonic, and is used in rheumatism, urinary affections, and anasarca. Dr. Gibson recommends its use as a diuretic. Mohamedan physicians consider the seeds as aphrodisiac. In Unani medicine the seeds are given in gonorrhoea and with milk and sugar in spermatorrhoea. The peculiarity of the seeds is that when they are placed in the mouth or water they become immediately coated with a large quantity of extremely tenacious mucilage.

The roots of this drug have been investigated by Warden (Pharmacographia Indica vol. III page 38), and by Ghatak and Dutt (Jour. Ind. Chem. Soc. 1931, 23). Warden found in the seeds traces of an alkaloid and 23 per cent. of a fixed oil. Ghatak and Dutt found in the roots a sterol which they termed Hygrosterol.

The present investigation was undertaken with a view to submit the seeds to a thorough and systematic examination. We did not find any alkaloid nor Hygrosterol. A pale yellow fixed oil was obtained in 21 per cent. yield. This oil belongs to the type of semi-drying oils. The Solid acids of this oil have been shown to be myristic, palmitic and stearic acids only. The presence of linolic acid has been shown in the liquid acids. The other acids present in the liquid acids are at present unknown.

EXPERIMENTAL

Moisture :—The percentage of moisture in the average sample of the seeds was determined by heating a weighed quantity at 100°C. The percentage loss was 8.43.

Ash :—A weighed amount of the seeds was incinerated and the percentage of ash was found to be 10.2. It was analysed qualitatively and was found to contain potassium, phosphorous and trace of iron.

Test for Enzymes :—50 grms. of the ground material were soaked in water and kept overnight in a corked flask. Next day the mass was swollen and the cork was blown out due to the immense pressure mostly of Carbon dioxide. The top aqueous layer was filtered. The filtrate was found to contain a reducing sugar, thus proving the presence of enzymes in the seeds.

Test for alkaloids :—50 grms. of the powdered seeds were digested with Prolius' fluid. The filtrate on being examined in the usual manner for the presence of alkaloids, gave negative results.

Tests for Starch, tannins etc. :—10 grms. of the seeds were treated with 100 c.c. of distilled water and warmed on the water bath for half an hour. The mixture was then filtered and the filtrate when tested for (1) starch with dilute iodine solution indicated its absence, (2) tannins with ferric chloride indicated its absence, (3) reducing sugar with Fehling's solution showed its absence.

Test for volatile oil :—100 grms. of the material were distilled with steam and about 500 c.c. of the distillate were collected. The latter was not acidic nor was it found to contain any volatile oil.

Extraction with different solvents :—In order to ascertain the general character of the constituents 50 grms. of the ground material were successively extracted in a soxhlet apparatus with different solvents. The percentage of extracts dried at 100° and the nature of extracts are given in table I.

TABLE I.

	Solvent used	per cent. of extract	nature of extract
(1)	Petroleum ether	21	A pale yellow oil
(2)	Ether sulphuric	1.06	A dark red semi-solid mass.
(3)	Chloroform	0.5	A reddish black liquid.
(4)	Alcohol	8.87	Thick resinous mass.

Investigation of the oil :—6 lb. of the seeds were extracted in a soxhlet apparatus with petroleum ether B.P. 60° to 80°. The petroleum ether was removed on the water bath and the resulting oil was

kept in a vacuum desiccator over solid paraffin wax to remove the last traces of petrol. The oil thus obtained was used for all the work detailed below. It had a pale yellow colour and sweet taste like an edible oil. It was free from nitrogen and sulphur. The physical and chemical constants were determined by standard methods and are given in table II.

TABLE II.

Analytical constants of the oil from *Hygrophyla Spinosa*.

(1) Density at 30°	0.9254
(2) Refractive index at 33°	1.469674
(3) Iodine Value Wijs's method	122.1
(4) Saponification Value	206.5
(5) Acid Value	2.65
(6) Unsaponifiable matter	7.5 per cent.
(7) Reichert Meissl Value	0.25
(8) Polenske Value	0.46
(9) Acetyl Value	39.4

Mixed fatty acids :—150 grms. of the oil were saponified with alcoholic caustic soda solution. The dry soap was then extracted with petroleum ether to remove the unsaponifiable matter. The soap was then decomposed with dilute sulphuric acid and the liberated fatty acids were separated, washed and dried. The mixed fatty acids had the constants shown in table III.

TABLE III.

(1) Titre test	28.85°
(2) Melting point	32.2°
(3) Neutralisation value	190.17
(4) Mean molecular weight	295.3
(5) Iodine value	125.8
(6) Refractive index at 33°	1.46264

The mixed fatty acids were then separated into the solid and liquid acids by Twitchell's lead-salt alcohol method. (J. Ind. Eng. Chem, 1921, 18, 806). 20 grms. of the mixed fatty acids were dissolved in 250 c.c. of 95 per cent. by volume of alcohol. 20 grms. of lead acetate were dissolved in 250 c.c. of alcohol. Both were heated to boiling and then mixed and allowed to cool to room temperature. It was kept at 15° for several hours. The precipitated lead salts were filtered and washed with 100 c.c. of cold alcohol. From the combined filtrates alcohol was removed on water bath in a current of carbon dioxide. The remaining lead salts were taken up in ether, decomposed with dilute nitric acid, the ether layer was washed with water till free from mineral acids, dried over anhydrous

sodium sulphate and ether removed in a current of carbon dioxide. The liquid acids thus obtained are termed liquid acid I. The lead salts of the solid acids were again dissolved in 250 c.c. of alcohol containing, 1 c.c. of acetic acid. The solution was cooled and kept at 15° for several hours. The precipitated lead salts were filtered and washed with little alcohol. The free solid acids were obtained from the lead salts in the usual way. From the filtrate the liquid acids were recovered as described above and are termed liquid acid II. The results of two separations is given below.

	Weight of the mixed acids	Liquid acid I	Liquid acid II	Solid acids.
I	20 grms.	12.0 grms.	2.7 grms.	4.9 grms.
II	40 grms.	23.0 grms.	5.1 grms.	9.8 grms.

The percentage of the liquid and the solid acids in the mixed fatty acids is therefore :—

Liquid acids 75 per cent.

Solid acids 25 per cent.

The constants of the solid and liquid acids are given in table IV

TABLE IV.

Constants	Solid acids	Liquid acids I	Liquid acids II
Iodine Value	7.0	143.0	139.0
Neutralisation Value	211	190.3	184
Mean molecular weight	265.8	294.8	305
Melting point	60°		
Refractive Index at 30°	—	1.47125	1.46977

Solid acids :—The saturated acids were esterified by the Fischer Speier method by boiling for 4 hours with four times their weight of methyl alcohol containing 5 per cent. of dry hydrogen chloride. The esters were poured in water and extracted with ether. The ether solution was washed with a solution of sodium bicarbonate to remove any unesterified acids. The ether extract was dried over sodium sulphate and the esters recovered. They were then fractionated in modified Claissen flask at 4 m.m. pressure. The results are given in Table V.

TABLE V.

Fractional distillation of 30.5 grms. of the methyl esters of solid acids at 4 m.m. pressure.

No. of fraction	B. P. in degrees C	Wt. in grms.	Saponification Value	Mean molecular weight
I	below 155	0.15	—	—
II	155-160	4.12	217.0	258.5

III	160-165	4.45	204.5	274.3
IV	165-170	14.76	204.4	274.5
Residue	—	6.77	198.3	284.0

The first fraction was almost alcohol and was therefore neglected. Fraction 2. This was a mixture of palmitic and myristic esters. The ester was hydrolysed and the resulting mixture of acids was crystallised from alcohol when a small quantity of myristic acid M.P. 53° and M. W. 228 was isolated. Hence assuming this fraction to consist of methyl myristate and methyl palmitate the composition of this fraction is:—

Methyl myristate	41.1 per cent.
Methyl palmitate	58.9 per cent.

Fraction 3. This was a mixture of palmitic and stearic esters. The mixture of acids obtained on hydrolysing this fraction was purified by the fractional precipitation of the magnesium salts. The acids were just neutralised with KOH in alcoholic solution and magnesium acetate solution added just enough to precipitate one-third of the total acids. The precipitated magnesium salts were filtered and the acid recovered from them. This on crystallisation from alcohol had M.P. 69° and M.W. 284. and was identified as stearic acid by mixed M.P. with an authentic specimen. The acid recovered from the more soluble magnesium salts had M.P. 62°C and M.W. 256. and was identified as palmitic acid. The composition of this fraction is Methyl palmitate 84.64 per cent. and methyl stearate 15.36 per cent.

Fraction 4. This was similar to the above fraction and consisted entirely of methyl palmitate and methyl stearate. The composition of this fraction is methyl palmitate 83.93 and methyl stearate 16.07 per cent.

Residue. The M W. suggests that no acid higher than stearic acid can be present and actually none was isolated. On the assumption that this fraction consists of palmitic acid and stearic acid only the composition is methyl palmitate 50 per cent. and methyl stearate 50 per cent.

Therefore the composition of the solid acids is,

Myristic acid	5.5 per cent.
Palmitic acid	73.0 per cent.
Stearic acid	21.4 per cent.

Unsaturated acids.

The liquid acids were examined by the bromine addition method of Jamieson and Baughman (J. Amer. Chem. Soc. 1920, 42, 2398).

The acids were dissolved in 100 c.c. of ether and cooled, and a cold solution of bromine in ether was added. It was kept at 0° for four hours. No precipitate of hexabromide was obtained. It is definite, therefore, that linolic acid was absent in the unsaturated acids. The solution was washed with a solution of sodium thiosulphate to remove the excess of bromine, dried over sodium sulphate and ether distilled off. The residue was dissolved in 150 c.c. of petroleum ether (B. P. 60°–65°) and kept in an ice bath for two hours. The precipitate of tetrabromo stearic acid was filtered through a gooch crucible and the filtrate concentrated. The precipitate obtained on cooling the solution was filtered through the same gooch. The weight of tetrabromo stearic acid, its M.P. and the bromine content were determined. From the filtrate the solvent was removed and the weight and the bromine content of the residue were ascertained. The results of bromination of the liquid acids I and liquid acids II are recorded below.

Bromination of liquid acids I.

Weight of acid taken	= 3.8623 gms.
Weight of tetrabromo stearic acid	= 2.19 gms.
Per cent. of Bromine in the above	= 53.36
M.P. of tetrabromo stearic acid	112°–113°–
Weight of the residue of di-and tetra-bromo acids.	4.963 gms.
Bromine content of the residue	= 41.76 per cent.

Bromination of liquid acids II.

Wt. of acids taken	1.1156 gms.
Wt. of tetra bromostearic acid	= 0.1991 gms.
Per cent. of bromine in the above compound	53.34
M.P. of tetra bromo stearic acid	113°
Wt. of the residue	1.6827 gms.
Per cent. of bromine in the residue	40.68

The M.P. and the bromine content of tetrabromo acid confirms the presence of linolic acid in the liquid acids. The molecular weight of liquid acids (compare table IV) indicates the presence of an acid of high molecular weight. Erucic acid cannot be present because the bulk of it would have remained in the solid acids in the separation of the solid and liquid acids by lead salt alcohol method as shown by Sudborough, Watson and Damle (Jour. Ind. Inst. of Science 1926, Vol. 9 A, part II page 29). The iodine value of the solid acids shows that erucic acid is not present to any considerable extent in the solid acids. Oxidation of liquid acids was carried out with a view to find out the presence of oleic acid and the other unsaturated acid of high

molecular weight, but the results were not conclusive. Hence at present the composition of the liquid acids cannot be calculated.

Unsaponifiable matter :—It was obtained by extraction of the dry soap with petroleum ether. On twice crystallisation from alcohol it had the m.p. 114–115° C. It gave all the colour reactions of phytosterol. Though the amount of the unsaponifiable matter in the oil is considerable (viz. 7.5 per cent.) still most of it was a gummy mass, only a small fraction being obtainable in the crystalline state. Hence it was not possible to characterise the sterol present in the unsaponifiable matter.

With a view to throw light on the nature of the unsaturated acid of high mol. wt. present in the oil experiments on the hydrogenation of the oil are in progress.

We thank Dr. M. S. Shah, Head of the chemistry department for facilities.

CONDENSATION OF PHENOLS AND PHENOLIC ETHERS WITH ACETONE DICARBOXYLIC ACID.

PART II.

β-Substituted cyclobutenone carboxylic acids.

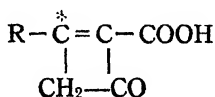
BY

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It has been shown in part I of this series (J. Ind. Chem. Soc. 1931, VIII, 787) that, phenol, anisol and *o*-cresylmethyl ether condense with acetone dicarboxylic acid, each giving a para substituted (1) glutaconic acid and (2) monobasic ketonic acid.

This latter compound was obtained in greater quantity by (1) immediate crystallisation of the product precipitated on pouring the reaction mixture of phenol and acetone dicarboxylic acid into ice; (2) heating the corresponding para substituted glutaconic acid at its m. pt. and (3) heating the glutaconic acid with acetyl chloride. The new acid changed to the glutaconic acid in moist air and in dilute alcohol, which was regarded as hydrolysis since, the new acid, on analysis, was found to contain one molecule of water less than the corresponding glutaconic acid. The hydrolysis was hastened with alkali and stopped in desiccator as usual. The new compound is supposed to be a β -substituted cyclobutenone carboxylic acid of the general formula :—

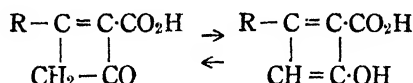


On submitting the new compound to several reactions, the following experimental results were obtained :—

- (1) Each of the new compounds titrated as a monobasic acid and formed a stable barium salt.
- (2) The new acid formed a monoacetyl derivative which could be titrated as a monobasic acid. A diacetyl derivative was obtained when there was a free—OH group in R.

(*C being in the para position with respect to the hydroxy or the methoxy group in R.)

- (3) The new acid gave a monochloro derivative with phosphorous trichloride. The monochloro compound titrated as a monobasic acid.
- (4) The new compound yielded a monosemicarbazone and a mono hydrazone.
- (5) The new acid also formed a mono isonitroso derivative. The enolic and ketonic action of the compounds can be accounted for by the tautomeric formula :—



According to Bland and Thorpe (Trans, Chem. Soc. 1912, 107, 859) action of acetyl chloride on β -phenyl glutaconic acid produced an anhydride which was however found to behave in the same way as described under (1) and (3) with respect to titration and action of phosphorous trichloride. These reactions which are not expected from a normal anhydride were explained by them on the assumption of the mobility of a hydrogen atom in the methylene group in the normal anhydride and its consequent transformation into a stable hydroxy

anhydride of the formula :— $\text{R}-\text{C} \begin{array}{l} \text{CH}-\text{CO} \\ \swarrow \quad \searrow \\ \text{CH}=\text{C}(\text{OH}) \end{array} \begin{array}{l} >\text{O} \\ \text{O} \end{array}$

They were not able to obtain the normal anhydride of β -phenyl glutaconic acid.

Their formula of a hydroxy anhydride however falls short to explain reactions Nos. (2), (4) and (5) mentioned above, manifested by the compounds isolated in this work; the formula of β -substituted cyclobutenone carboxylic acid seems to explain all reactions described above in a satisfactory manner. Besides, the formation of a hydroxy anhydride has not been conclusively established by Thorpe and his co-workers and the conversion of the two types of anhydrides into one another has not been reported.

EXPERIMENTAL.

α -Carboxy- β -(4-hydroxyphenyl) cyclobutenone, from

(a) *phenol and acetone dicarboxylic acid* :—The reaction was carried out exactly as given in part I. The flocculent precipitate obtained by pouring the reaction mixture on ice was quickly separated on cotton wool and washed with a small quantity of alcohol. The mass of cotton wool was transferred to a beaker and the adhering product was crystallised from absolute alcohol, quickly dried and kept in a sealed tube: yellowish silky needles m.p. 224° ;

yield, 20%. (Found: Equivalent wt., 203.7; C, 64.66; H, 3.85. $C_{11}H_8O_4$ requires Eq. wt., 204; C, 64.7; H, 3.93 per cent.) *Barium salt* precipitated from a dilute alcoholic solution of the acid by barium acetate. (Found: Ba, 25.4; $(C_{11}H_7O_4)_2$ Ba requires Ba, 25.23 per cent.)

(b) *From β -4-hydroxyphenylglutaconic acid by (i) heating it at its m. pt.*:—The pure glutaconic acid (5 g.) was heated in a hard-glass tube in a paraffin bath at 195° for 45 minutes under a drying tube and cooled. The solid residue gave yellowish needles from absolute alcohol: m.p. 224° ; yield, 60%. Mixed with the compound in (a) m.p. 223° .

(ii) *By the action of acetyl chloride*:—The glutaconic acid (5 g.) was refluxed with acetyl chloride (10 c.c.) in a dry atmosphere on a water-bath for 2 hours. The acetyl chloride was evaporated and the residue extracted with ether. The ethereal solution was shaken with sodium bicarbonate solution which was then separated. This alkaline solution on acidifying deposited a sticky mass which solidified with alcohol in the refrigerator and gave yellow crystals from absolute alcohol: m.p. 224° ; yield, 20%. Mixed with the compound in (a) m.p. 224° . Pinkish needles of the diacetyl derivative (m.p. 123°) were obtained from the mother liquor after 24 hours.

Hydrolysis of α -carboxy- β -(4-hydroxyphenyl)-cyclobutenone—by 10% solution of sodium hydroxide gave theoretical yield of β -4-hydroxyphenyl glutaconic acid: prismatic crystals m.p. 184° with decomposition. Mixed with the synthetical glutaconic acid of part I: m.p. 183° with decomp.

The diacetyl derivative:—This was obtained by heating the cyclobutenone acid (2 g.) with acetic anhydride (10 c.c.) and fused sodium acetate in a protected reflux for half an hour and pouring the reaction mixture into ice. The product solidified in contact with alcohol and gave pink leaflets from acetone and chloroform: m. p. 122° , yield, 70%. Mixed with the said diacetyl derivative of (b ii): m. p. 123° . (Found: Eq. wt., 286.9; C, 62.43; H, 4.21. $C_{15}H_{12}O_6$ requires Eq. wt., 288; C, 62.5; H, 4.16 per cent.). *Barium salt* crystallised from dilute alcohol. (Found: Ba, 19.25. $(C_{15}H_{11}O_6)_2$ Ba requires Ba, 19.32 per cent.).

The monochloro derivative:—This was prepared by heating the cyclobutenone acid (5 g.) with phosphorous trichloride (12 c.c.) under a protected reflux on a water-bath for two hours. The cooled mixture was poured over ice and the pasty mass which separated, was extracted with sodium bicarbonate solution and filtered. The

filtrate, on acidifying, gave a brownish powder which formed green rhombic plates from ethyl acetate: m. p. 143° ; yield, 20 %. (Found: Eq. wt., 222.14; Cl, 15.81. $C_{11}H_7O_3Cl$ requires Eq. wt., 222.5; Cl, 15.95 per cent.).

The monosemicarbazone:—This was obtained by shaking the solution of the cyclobutenone acid (2 g.) in absolute alcohol (20 c.c.) with semicarbazide chloride: Long white needles from ethyl acetate m. p. 258° with blackening. (Found: Eq. wt., 260; N, 16.2. $C_{12}H_{11}O_4N_3$ requires Eq. wt., 261; N, 16.1 per cent.).

The monohydrazone:—This was obtained by shaking a solution of the cyclobutenone acid in absolute alcohol with phenyl hydrazine hydrochloride and fused sodium acetate: Long yellow needles from chloroform, m. p. 193° . (Found: Eq. wt., 292.5; N, 9.52 $C_{17}H_{14}O_3N_2$ requires Eq. wt., 294; N, 9.5 per cent.).

The mono-isonitroso derivative:—This was obtained by warming a mixture of the cyclobutenone acid (2 g.), pure sodium nitrite (1 g.) and sodium acetate solution (20 c.c. of 10%) and pouring the mixture into ice cold acetic acid (25 c.c. of 20%). The brown powder which separated, formed red prisms from ethyl acetate: m. p. 201° with blackening; yield, 20%. (Found: N, 5.9. $C_{11}H_7O_5N$ requires N, 6.00 per cent.).

Table No. I (compounds from acetyl derivative of phenol.)

Name.	Formula.	Method of formation and yield.	Appearance and m p. or b.p.	Analysis.	
				Calc.	Found.
1. α -Carboxy - β -4 - acetoxy-phenyl cyclo-butenone.	$C_{13}H_{10}O_5$	Heating the corr. glutaconic acid with (1) acetyl chloride and (2) at its m. pt. Yield 25%.	Colourless needles; m p. 171°.	Eq. wt., 246. C, 63.4 H, 4.06	Eq. wt. 244.5 C, 63.5 H, 3.98
2. Acetyl derivative of (1) ...	$C_{15}H_{12}O_6$	Heating (1) with acetic anhydride; yield, 45%.	Pink leaflets; m.p. 122°; identical with the diacetyl derivative of α -carboxy- β -4-hydroxyphenyl cyclobutenone. Mixed m.p. 123°.		
3. Monochloro derivative ...	$C_{13}H_9O_4Cl$	Heating (1) with PCl_3 ; yield, 40%	Greenish plates from chloroform; m.p. 126°	Eq. wt., 264.5 Cl, 13.55	Eq. wt., 263.5 Cl, 13.71
4. Semicarbazone ...	$C_{14}H_{12}O_5N_3$	Shaking alcoholic solution with semicarbazide chloride and Na acetate.	Light silky needles; m p. 279°.	Eq. wt., 303	Eq. wt., 301.8
5. Isonitroso derivative ...	$C_{13}H_{10}O_5N$	Warming (1) with sodium acetate and sodium nitrite in alcoholic solution; yield, 25%.	Reddish violet needles; m.p. 212°.	N. 5.09	N. 5.00
6. β -4-Acetoxyphenyl-glutaconic acid.	$C_{13}H_{10}O_6$	Hydrolysis of (1) with dilute NaOH.	Mixed with the synthetical compound in Part I; m.p. 193° with decomp.		

Table No. II (Compounds from anisole).

Name.	Formula.	Method of formation and yield.	Appearance and m.p. or b.p.	Analysis.	
				Calc.	Found.
1. α -Carboxy- β -4-methoxyphenyl-cyclobutenone.	$C_{12}H_{10}O_4$	(i) Condensation of anisol with acetone dicarboxylic acid. (ii) Heating the corr. glutaconic acid (a) at its m.p. and (b) with acetyl chloride; yield, 40%.	Yellowish needles from alcohol; m.p. 160°.	Eq. wt., 218 C, 66.05 H, 4.58	Eq. wt., 217.8 C, 66.12 H, 4.49
2. Monacetyl derivative of (1).	$C_{14}H_{12}O_5$	Acetylation of (i) with acetic anhydride; yield, 60%.	Pinkish needles from alcohol; m.p. 118°.	Eq. wt., 260 C, 64.6 H, 4.6	Eq. wt., 258.5 C, 64.52 H, 4.7
3. Monochloro derivative of (1).	$C_{13}H_9O_5Cl$	See table No. I; yield, 55%.	Greenish plates from carbon tetrachloride; m.p. 162°.	Eq. wt., 236.5 Cl, 15.01	Eq. wt., 237.0 Cl, 14.95
4. Semicarbazone ...	$C_{13}H_{13}ON_3$	" " yield, 50%.	Short white needles from methyl alcohol; m.p. 213°.	N, 15.27	N, 15.22
5. Hydrazone ...	$C_{13}H_{13}ON_2$	" " yield, 90%.	Light leaflets from methyl alcohol; m.p. 188°.	Eq. wt., 308 N, 9.08.	Eq. wt., 307.2 N, 9.14
6. β -4-Methoxyphenyl glutaconic acid.	$C_{12}H_{12}O_5$	Hydrolysis of (1) by sodium hydroxide.	Mixed with the synthetical glutaconic acid of Part I. m.p. 176° with decomposition.		

Table No. III (Compounds from O-cresylmethyl ether).

Name.	Formula.	Method of formation and yield.	Appearance and m.p. or b.p.	Analysis.	
				Calc.	Found.
1. α -Carboxy- β -4-methoxy-3-methyl-phenyl cyclobutenone.	$C_{13}H_{12}O_4$	Condensation of o-cresyl-methyl ether with acetone dicarboxylic acid; yield 70%. See table No. I for the other 2 methods.	Pale yellow needles from alcohol; m.p. 166°.	Eq. wt., 232 C, 67.24 H, 5.17	Eq. wt., 231.1 C, 67.2 H, 5.20
2. Acetyl derivative of (1) ...	$C_{15}H_{14}O_5$	See Table No. II, yield, 35%	Reddish yellow needles from alcohol; m.p. 137° The barium salt.	Eq. wt., 274 C, 65.7 H, 5.11 Ba, 20.07	Eq. wt., 273.2 C, 65.6 H, 5.07 Ba, 20.0
3. Chloroderivative ...	$C_{13}H_{11}O_5Cl$	See Table No. I; yield, 25%	Yellowish prisms; m.p. 176° with decomposition.	Eq. wt., 250.5 Cl, 14.16	Eq. wt., 249.8 Cl, 14.2
4. Semicarbazone ...	$C_{14}H_{15}O_4N_3$	Yield, 50%	Silky white needles from acetone, m.p. 197°.	Eq. wt., 289 N, 14.53	Eq. wt., 290.1 N, 14.6
5. Hydrazone ...	$C_{14}H_{15}O_3N_2$	Yield, 60%	Orange leaflets from chloroform m.p. 189°.	Eq. wt., 322 N, 8.7	Eq. wt., 320.5 N, 8.65
6. β -4-Methoxy-3-methyl phenyl glutaconic acid.	$C_{13}H_{14}O_6$	Hydrolysis of (1) with alkali	Mixed with the same acid of Part I, m.p. 172° with decomposition.		

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The work is being continued.

THE FOURTH DIMENSION

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We are all gradually breaking away from traditions. We do not hold the same views in our social, religious, educational and professional spheres to-day as we held yesterday. The change in our outlook has been rather so rapid that our foundations have been almost shaken and many of us would have started becoming suspicious about the new course of events. One thing is however certain and that is, that even the most conservative of us are trying to understand the advantages of fresh air and ultra-violet rays and at least roam freely in the vast fields of rational thought. Such is the case with us, also, in following the course of Scientific thought during the last three hundred years and particularly during the last thirty years of the present century. The Aristotelian Science and Philosophy remained supreme under the holy sanction of the churches for nearly two thousand years. The first great shock was received from Copernicus ; Galelio, Kepler, followed ; Galelio particularly suffered a good deal of persecution at the hands of the Church Authorities in preaching his new ideas on matter, mass and motion. When Newton came, the times were ripe for an explosion. His Gravitational Theory of Matter which stated that each particle of matter attracted each other particle of matter whether terrestrial or celestial according to the Inverse Square Law was a revolutionary one in the world of Science. The Aristotelian Theory that celestial matter—the matter of which the stars, sun and other planets are composed—was much brighter and superior to the earthly matter, that there was something rhythmical and supernatural in the motions of the celestial bodies was pulled down, as, it could not stand Newton's analysis. After the later stir caused by the Electromagnetic Theory of Maxwell, followed the whole host of fresh theories. The Quantum Theory by Planck, the Theory of Relativity by Einstein, the Theory of the Structure of Atom by Rutherford and later as late as ten years ago, The Theory of Wave mechanics by Heisenburg, Shrodinger and De Broglie. Of all these the Theory of Relativity contributed most towards revolutionising our ideas and the conception of the Fourth Dimension in relation to the universe in which we live became handy to Einstein in illuminating his theory. His theory was tested and retested by experiments and every time it proved successful. We are thus drift-

ting in the world of a *four-dimensional continuum* and each one of us is taking the shortest route in this continuum.

What is the Fourth Dimension? What use is it? The fundamental needs of human nature are its quest after Art and Utility. The conception and the use of the theory of the Fourth Dimension supply both these needs. The theory is an art in itself in the realms of Mathematics and proves its use in abundance in the Relativity Physics. The theory is a beautiful one from the stand-point of a Mathematician and a very useful one from that of a physicist. We shall therefore first treat the theory mathematically and then point out its uses.

Can we imagine a Fourth Dimension? Can a Mathematician himself picture it? We all know what a one dimension is. If a particle is constrained to move on a line which is the simplest instance of one dimension (extension in length only) it requires one co-ordinate to specify its position at any time from the place from which it started viz. its distance from the place. (If a particle is travelling along any curve, its position at any time can also be specified by its actual distance from the point of starting: any curve can thus be regarded as one-dimensional). It requires two co-ordinates to specify the position of a point on a plane (extension in length and breadth) which is the simplest instance of a figure of two dimensions viz. x and y —its distances from two lines which are usually taken perpendicular to each other. A point has position but no extent i.e. is zero-dimensional. Its motion generates one-dimensional line. The one-dimensional line when moved in a direction perpendicular to itself generates a plane which has two dimensions. The two-dimensional plane when moved in a direction perpendicular to itself generates space which is three-dimensional—the space in which we live. In specifying the position of a point in our space, we require three co-ordinates viz. x, y, z its distances from three mutually perpendicular planes, for instance. In any other system of co-ordinates also, three co-ordinates are sufficient to assign completely the position of a point in our space. The co-ordinates x, y, z are analogous to our ideas of length, breadth and height. We are thus able to visualize the position of a point in our space; but, what happens when we try to extend these ideas a step further? Can we imagine a fourth direction not contained within our space and such that it is perpendicular to every line which can be drawn in our space? Can we picture to ourselves the space of our existence moving perpendicular to itself? Neither any person nor a Mathematician can do this but the Mathematician does not stop at his inability of physical perception. He does not even stop to think whether his mathematical extension in the fourth direction which he

does not perceive will have any uses. He only believes in generalizations of his ideas—beautiful extensions of the sphere of his art—irrespective of what uses they may be put to. When the Greek Mathematicians extended the elementary ideas of the Practical Geometry developed by the Egyptians, they did not care to know about its use and the disinterested development of geometry at their hands resulted in Euclid who handed down to us a geometry which is the same now as it was centuries ago when he compiled it. When Descartes in the seventeenth century discovered the co-ordinate Geometry of two dimensions, he merely wanted to solve some problems in which he was interested, irrespective of any use such a geometry would result into. He made the dull life-less equations of Algebra such as for instance $y=x$, $x^2+y^2=25$ speak with eloquence the wonderful properties they possessed. Bodyless phantoms became, as it were, endowed with beautiful bodies. To take only one instance, the Algebraic relation $x^2+y^2=25$ which merely stated that the sum of two squares was equal to twenty-five was according to Descartes visualized as the locus of a point which always moves at a constant distance of five units of length from a fixed point i.e. as a picturesque circle. Any relation between two variables such as $y=f(x)$ fell under the category of some curve and it became possible to study the properties of each species of a curve with an elegance and simplicity never found in geometrical methods alone. Geometry supplied Algebra with imagination, as it were, and Algebra gave Geometry wings. Applications of the analytical methods of Descartes to curves and surfaces in space resulted in the Geometry of three dimensions which further simplified the study of Algebraic relations between the three variables x, y, z , the simplest of them being $x+y+z=k$ and $x^2+y^2+z^2=k^2$ which we now picture to ourselves as a plane and a sphere. If geometrical forms can thus be used with regard to equations involving two and three variables, why can't they be used with regard to equations involving four variables? A plane with two dimensions is required to represent forms involving two variables; a space of three dimensions is required to represent forms involving three variables. A four-dimensional space would thus be required to study algebraic forms involving four variables. It would thus be clear that a fourth dimension arises out of the imagination of a Mathematician as a natural result of his joy in extending his results and generalising them as far as he can.

The Fourth dimension extends vision. A circle when viewed as a one dimensional curve is merely a curved path: when viewed in two dimensions it has a centre and a fixed radius: viewed in three dimensions it is further related to surfaces such as a sphere, a cylinder, a cone etc. Thus the properties of a circle increase in number as

it is viewed in space of higher dimensions. Similarly the properties of any given line or surface will increase in number when investigated in hyperspace. Also, as it requires a three dimensional space to include certain one-dimensional curves (the helix for instance), so in hyper-space hitherto unknown lines and surfaces become mathematically possible. Just as the comprehension of plane geometry is enlarged by viewing plane figures in space, so solid geometry is much illuminated by the geometry of Hyperspace. Hence also the need of the Geometry of the Fourth dimension.

In the Geometry of four-dimensions, four mutually perpendicular lines are taken as the axes of reference, three of which lying in our space, we are able to see. We cannot see how a fourth line can be made perpendicular to the three mutually perpendicular lines at their common point but a mathematician is not stopped at this physical difficulty. He imagines, he can draw such a hypothetical line and deduces the consequences of his hypothesis. Some simple deductions on this hypothesis are given below :—

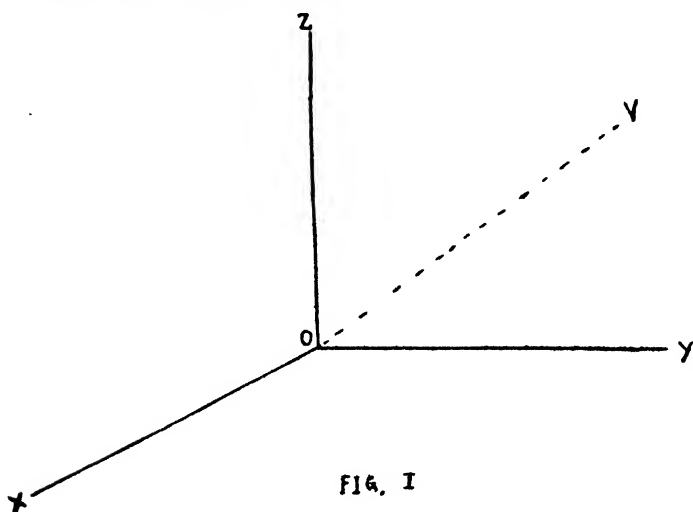


FIG. I

In figure I above, OX, OY, OZ are three mutually perpendicular axes in our space. The invisible OV which is dotted goes out in the fourth direction not contained within our space and is perpendicular to all the lines in our space. Compounded from the four axes in pairs, there are six planes of reference these being XOY, YOZ, ZOY, XOY, YOY, ZOY. These six planes are to be regarded as perpendicular in all the fifteen pairs. Compounded from the four axes in three, there are four flats (three-spaces) of reference these being OYZV, OZVX, OVXY, OXYZ. These four three-spaces are to be regarded as perpendicular to each other in all the six pairs. They are also

respectively perpendicular to the four axes OX , OY , OZ , OV . Now OZ and OV are both perpendicular to every line in the plane XOY ; therefore, every line in the plane ZOV is perpendicular to the plane XOY . Planes XOY and ZOV are therefore called absolutely perpendicular. The most that we could see in any three-space of two absolutely perpendicular planes would be one of the planes and a single line of the other e.g. the plane XOY and the line OZ belonging to the plane ZOV . The two planes XOY and ZOV meet at point instead of a line as is the case in three dimensions. In fact two planes which do not lie in the same three-space will not have more than one point in common.

Let us consider what the simplest solid in a space of four dimensions would be. A line unit long moving perpendicular to itself generates a square. The square moving perpendicular to its plane through a unit distance generates a cube. The cube moving perpendicular to its three-space through a unit distance generates a hypercube. We know that the cube has eight corners, twelve edges, and six faces. The hypercube is generated by the motion of the cube through unit distance in the direction of the fourth direction. Thus the hypercube will have sixteen corners, eight of these belonging to the initial position of the cube and eight others to the final position of the cube after it has moved through unit distance in the fourth dimension. It will have thirty-two edges, twenty-four faces, and eight bounding cubes. Each corner of the hypercube is common to four mutually perpendicular edges, to six square faces and to four cubes. Each edge is common to three faces and three cubes and each face is common to two cubes.

In our space, there are only five regular polyhedrons (solids bounded by equal regular polygons) viz., the Tetrahedron, cube, Octahedron, Dodecahedron and Isocahedron; in the space of four dimensions, there would be six regular hypersolids bounded by regular equal polyhedrons. Of these, the first one is bounded by five tetrahedrons, the second by eight cubes, the third by sixteen tetrahedrons, the fourth by twenty-four octahedrons, the fifth by one hundred and twenty dodecahedrons and the sixth by six hundred tetrahedrons. The Hypercube which has been considered above is the simplest of all, as, though it has more bounding solids than the first regular hypersolid, it is right-angled throughout and therefore the standard form for measuring Hyperspace.

The freedom of movement is greater in hyperspace than in our space. In our space, we can have six independent motions—three linear motions (translations) in the directions of the three axes and three rotations about the axes. If we fix three points of a body in

our space, it will prevent all its movement. On the other hand, in the space of four dimensions, there can be four independent translations along the axes and six independent rotations about the six planes of reference. In the hyper-space, if the body is fixed at three points, it can still rotate about the plane containing the three points while at least four of its points must be fixed to prevent all movement. With this greater freedom of movement, things which are not possible for a three-dimensional being become possible for one who is four-dimensional. As we are three-dimensional beings, we have greater freedom of movement than the two-dimensional beings, if any such exist, and the two-dimensional beings, would have greater freedom than the one-dimensional beings (if any). Two dimensional beings would be flat : they would have length and breadth but no height at all. If they have houses, they will consist of walls which are lines and a door will be found by a small break in the line. Their eyes will have one curvature only and the images of objects will fall on a linear sensitive spot. A three-dimensional being can enter the locked room of a two-dimensional being by putting his feet across its walls which have no height i.e. from the direction of the third dimension and play all sorts of pranks such as lifting the hat of the two-dimensional being or stealing away a few of his valuables without breaking through the walls. The two-dimensional being would gape with wonder as to how such extraordinary events could take place. Similarly the three-dimensional beings cannot maintain their privacy before four-dimensional beings, if such exist, even in perfectly closed rooms. We get reports of ghosts entering into closed rooms and surprizing the inmates of the rooms with strange noises and weird cries without being visible. Are ghosts of departed souls, if they exist, four-dimensional? The spiritualists led by Professor Zollner in Gernal thought that the fourth dimension was the abode of the spirit world. Is God who is believed to exist and see in the minutest nooks and corners four-dimensional? Are dreams four-dimensional? Is this the reason of a number of events being viewed in a moment in the dreams? Has ether which possesses so many contradictory properties anything to do with the fourth dimension?

The question of symmetry is a fascinating one.

B A' 0 A B

FIG II

In figure II below lines AB and $A'B'$ are symmetrical about the point O and are lying on an extended one-dimensional line. It will not be possible for us to make A coincide with A' and B with B' by *any* motion along the line but when AB is rotated through 180° in the two-dimensional plane of the paper and moved so that A coincides with A' and B with B' , this will be possible.

In figure III below, the two triangles ABC and $A'B'C'$ are symmetrical with respect to the line XY in the plane of the paper. The triangle ABC cannot be made to coincide with the triangle $A'B'C'$ by any movement in the plane whatever but it will have first to be turned upside down in the space of three dimensions and moved to coincide with $A'B'C'$ i.e. a rotation of the triangle ABC through 180° in the space of three dimensions is necessary before it can be made to coincide with $A'B'C'$.

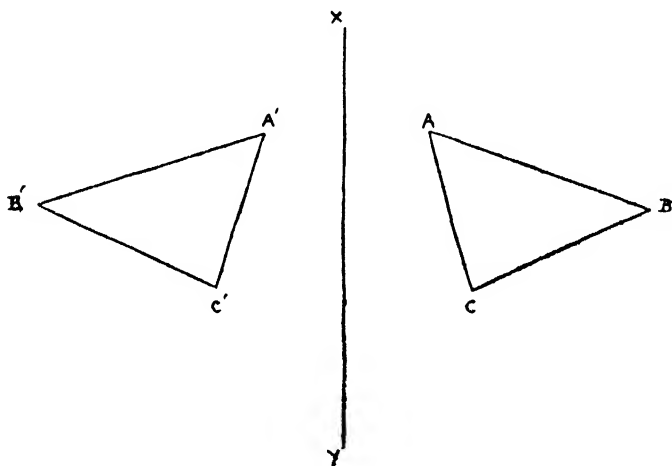


FIG. III

Similarly two figures which are symmetrical with respect to a plane in three-dimensional space can be made to coincide with each other if one of them is taken in the fourth dimension, rotated there through 180° and then placed on the other. The operation of making two symmetrical figures coincide has to be, therefore, always made in a higher dimension. A right glove, turned over through the space of four dimensions becomes a left glove; a right shoe becomes left shoe. A right-handed man becomes a left-handed man. He does not use a different hand after his rotation through 180° in the fourth dimension, but the hand which he then uses appears to everybody else as his left hand. In fact, his point of view is changed so that every body else appears to him changed also. Letters appear to him turned backwards as in the Printing Press, the hands of a clock go

backward and the whole world appears to him as a looking-glass world.

We do not know whether there is a four-dimensional space but on the hypothesis of its existence, we have so far deduced some of the interesting consequences. A Mathematician can build up as many geometries as he likes : only these will depend on the hypotheses with which he starts. His development of the two Non-Euclidean Geometries known by their titles—Hyperbolic Geometry and Elliptic Geometry—shows us that he does not care so much for the use of those Geometries as for the logic of the system he pursues and for the extension of thought in unexplored fields. There are certain statements in Geometry which are considered as Axioms ; these are supposed to be self-evident truths and do not require any proof. There are other statements which are known as postulates which may not be self-evident but which cannot be proved by any simpler proposition. One of the postulates of Euclid runs as follows : “ If a straight line falling on two straight lines make the sum of the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than two right angles.” Many geometers tried to demonstrate its truth. Great ingenuity was expended but no advance was made till modern research vindicated Euclid and justified his decision in assigning his great proposition a place amongst the independent assumptions necessary for the development of Euclidean Geometry as a logical system. Since the truth of the parallel postulate cannot be demonstrated by any simpler axiom, both Lobachevsky in Russia and Bolyai in Hungary denied it as true and independently worked out a system of Geometry on the hypothesis that two lines can be drawn through a point parallel to a given line. The Geometry of both of them is as logical and consistent as that of Euclid's and is known as Hyperbolic Geometry. Riemann further argued that yet another self-consistent Geometry could be built up on the hypothesis that no straight line could be drawn through a given point parallel to a given line. This Geometry was called Elliptic Geometry. The two non-Euclidean geometries were logically as consistent as Euclid's but were considered to be inconsistent with reality until a space was known for which they were found to be true. It was found that Riemann's geometry was none other than that of the spherical surface (a two-dimensional surface of constant positive curvature) provided arcs of great circles are taken as geodetic lines. In 1868, the Italian Beltrami discovered a surface for which Lobachevski's Geometry held true—the so called pseudo-spherical surface of infinite extent (a two-dimensional space of constant negative curvature).

Riemann also showed that there are logically also three kinds of space of three dimensions, with properties analogous to the two-dimensional spaces mentioned. They are distinguished by the so-called measure of space curvature (purely analytical, not denoting curvature for sense-perception). If this constant is zero, we have Euclidean space; if positive, spherical space; and, if negative, a pseudo-spherical space.

A Mathematician can thus, logically build up as many geometries as the hypotheses with which he starts and we make use of that particular geometry which fits in with our experience and conditions of our existence. What is the use of the Geometry of the Fourth Dimension? It has been so far customary to describe the three-space in which we live as flat, uncurved space. This description is tacitly assumed on the ground that the linear property is obvious and is approximately correct so far as observations within normal distances go. Now, the Theory of relativity has been established beyond doubt and mathematical calculations involved in the theory show that on a grand scale in which large stellar distances are considered, the space of our universe is not uncurved. The very notion of curvature for a curve or a surface or a region implies some uncurved configuration by reference to which the curvature can be defined and estimated. Thus, the curvature at any point of a curve, which exists in the Euclidean space of two or three dimensions is a mathematical measure of the deviation of the curve from straightness, the measure being framed by reference to successive straight lines in the two-dimensional or three-dimensional space in which the curve lies. Also, the curvature at any point of a surface is estimated with reference to its organic geodetic curves: and all these curvatures are estimated by reference to deviations from straight lines in the Euclidean three-space containing the two-dimensional surface. It would be thus clear that the important conception is, that in framing a mathematical measure of curvature of any curved configuration, we require an uncurved space more extensive in dimension than the curved configuration in question. If, therefore, as the Theory of Relativity shows, the space of our universe is a curved one, the mathematical conception of the curvature of such a space would require the existence of some further space of ultimate reference characterised by complete linearity. Thus has arisen the demand for at least one more dimension, additional to the three dimensions possessed by our space. Hence the use of the Geometry of four dimensions.

Also, time as a co-ordinate is gradually assuming an independent position of a fourth dimension although in a different sense from the usual one attached to the word dimension. Nothing lives at no time

or no-where. For a complete specification of an object, its location in space and time simultaneously is necessary. Consider, for instance, our material bodies. We are conscious of a gradual change of shape and position of all its parts and yet at the same time, we are conscious of a continuing identity throughout all these changes. Our past experiences are as real as the experiences we are now undergoing. Those past experiences or phases of our existence are as much a part of us as the present ones and yet owing to the limitations of our senses, we can reproduce past conditions only in memory. Nevertheless, our lives in their completeness are made up of the sum total of our experiences and if our whole lives are considered as units and each period of which we are conscious requires a three-dimensional space, then each individual may be regarded as a four-dimensional solid.

When Einstein announced his Theory of Relativity, he said that observers in different relative motion would make different observations on the same event. The events which would for instance be recorded as simultaneous by an observer on Earth would not be simultaneous for an observer on Mars; on the other hand events which take place at different times on Earth may be seen as simultaneous by an observer on Mars. Again, the distance between any two bodies measured by observers on Earth and Mars will not be the same. Einstein asserts that the length and time-lapse are relative conceptions. They vary with the state of motion of an observer. A man carries, as it were, his own particular space and time about with him. The behaviour of his instruments, the measuring rods and clocks varies with his motion. There is no experiment whatever which will show the observer whether he is absolutely at rest.

Each observer carries his own space and time about with him but though they vary in their measurements of length and time, they all invariably arrive at the same figure for the velocity of light viz, 186000 miles per second. Also, if any given observer takes his space and time measurements on a pair of events and combines them in a certain way, he will get a certain result. If another observer combines his measurements for the same pair of events in the same way he will get the same result. The precise technique by which the measurements are combined is of no importance to our argument. The important fact is, that there exists a relation between any pair of events which is the same for all observers. This relation, it is obvious, is more fundamental than either space or time taken separately. It refers to something which does not vary with the state of the observer. What is this something?

The correct interpretation of the fact that there is an invariant relation between any two events is given by Minkowski. He showed

that this relation (which is called the interval) was, in its mathematical expression, analogous to the mathematical expression for a distance. He suggested, therefore, that the interval is a distance of some kind. But if the interval is to be regarded as a distance, it must be regarded as such in a *four-dimensional continuum*. Minkowski did not hesitate to take this step. The actual universe in which events exist is, he asserted, a four-dimensional universe. Our minds split up this universe into three dimensions of space and one dimension of time. Different observers, as we have seen, split up the universe differently. They take different cross-sections, as it were, of the four-dimensional reality ; therefore, they have different space and time measurements. Only those quantities which refer to the four-dimensional reality itself are the same for all observers. Of such quantities the interval is one.

The fact that the interval could be regarded as a distance in a four-dimensional continuum immediately illuminated the whole Theory of Relativity and showed it in more relief. It showed that the geometry which must be applied to the universe was not as had been supposed Euclidean Geometry. The formula for the interval, if interpreted as a distance, made it clear that the geometry of the four-dimensional continuum was not Euclidean. It can be deduced, for instance, that in a continuum subject to this geometry, there is a maximum velocity. In a Euclidean continuum (our space of three dimensions regarded as flat), it is theoretically possible for an infinite velocity to exist. Whatever speed the particle is travelling at, we can always imagine it travelling at a greater speed. But in a continuum, governed by the geometry of four dimensions called semi-Euclidean, this is not the case. An infinite velocity is not possible in such a continuum. The ultimate velocity is a certain finite velocity viz., the velocity of light. It is therefore strongly confirmatory of Minkowski's conception of the universe as a four-dimensional continuum that the velocity of light is found in the Relativity Theory to play the part of an ultimate velocity. The velocity of a material body cannot, according to the Theory of Relativity, ever exceed the velocity of light ; for it can be shewn that the mass of a body increases with its velocity and increases in such a way that at the velocity of light, it is infinite. This can only mean that the speed of light is a natural limit of moving matter.

The Theory of the four-dimensional continuum has been thus proved very helpful to the Theory of Relativity, which has been tested and retested and generally acknowledged as true. It would be, therefore, so far true to say that physically all of us are born, brought up and move in our courses in a four-dimensional continuum. The

Fourth Dimension has been, mathematically, an artistic phantom of a mathematician's imagination but physically it has turned out to be the fruitful union of time with space in a four-dimensional continuum.

The four-dimensional Geometry can be and has been, in fact further extended by writers such as Cayley, Grassmann, Riemann and the Italian Geometer Veronese. The Physicist makes use of this geometry in picturing the atom which escapes being photographed every time the lens of his experimental methods is held towards it. The Theory of the Atom was first found seriously insufficient in 1925 and since that time, an entirely different picture has been developed by Heisenberg, Shrodinger, De Broglie etc. This Theory is however entirely mathematical.

The electron, for instance, on this theory is described not as a particle but as a system of waves. These waves are located within what is called "Configuration Space". This configuration space is certainly not ordinary physical space for the reason that each electron requires a three-dimensional configuration space to itself. Thus two electrons require a space of six dimensions in which to exist, three electrons a nine-dimensional space etc.

A modest attempt has been made in the above lines to show that the strange conception of the fourth Dimension has been found both picturesque and useful. If the attempt has also served the purpose which it was also meant to serve, of elucidating the ideas underlying the conception to a non-mathematical reader of the journal, the writer would feel content.

THE TEACHING OF GEOMETRICAL OPTICS

BY

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In the year 1929, the Physical Society of London held a general discussion on the teaching of geometrical optics. Following this, a committee was appointed to examine and report on the whole question. The report was published last year.* The committee was widely representative of physicists engaged in industry, teaching, and research, including members of great eminence, so that the report must necessarily carry great weight. It is therefore opportune to draw the attention of physics teachers to the problems discussed in this report, and to the recommendations made.

The investigation showed (as, indeed, most physics teachers knew) that there exist great divergencies in the methods employed in the teaching of geometrical optics, particularly in its elementary stages; and that the methods employed by practical opticians differ from those generally used by teachers. The committee were strongly of the opinion that more uniformity is desirable, especially in regard to standard definitions and conventions of signs. Text-books differ widely amongst themselves, to the confusion of the student who is energetic enough to consult more than one; and furthermore, a student who subsequently enters the optical industry has generally to learn a new system of conventions and change his whole approach to the subject.

Certain recommendations are strong and unanimous, such, for example, as that the sign convention for the focal lengths of lenses and mirrors, universally employed amongst practical opticians, should be adopted by teachers also. Thus a converging system (a concave mirror or a convex lens), is positive, and a positive sign is attached to its focal length. Conversely, a diverging system (a convex mirror or a concave lens) is negative, and has a negative focal length.

In the optical industry, however, a lens is generally specified by its power rather than by its focal length. This should also be done by physics teachers, who at present very often work exclusively with focal lengths. It is almost unnecessary to point out how this simplifies

* Report on the Teaching of Geometrical Optics: Physical Society: 1934.

the calculations. Thus, for two thin lenses in contact, the equation

$$F_1 + F_2 = F$$

gives the properties of the combination much more simply than

$$1/f_1 + 1/f_2 = 1/f.$$

The power should have the same sign as the focal length. The magnitude of the power, for a lens or mirror, is the reciprocal of the focal length in metres. Conversely, the focal length is the reciprocal of the power expressed in dioptries. The definition of power for a more complex optical system, such as a telescope, is considered in the report, and the following standard definitions are recommended :

- (a) A reflecting or refracting instrument is said to be of zero power if the image it forms of an infinitely distant object is at an infinite distance from the instrument.
- (b) Axially symmetrical instruments not of zero power are either of positive or negative power. An instrument is said to be of positive power if it produces an inverted image of an infinitely distant object, and of negative power if it produces an upright image of an infinitely distant object.
- (c) The numerical value of the power of the instrument (measured in dioptries) is the small angle (measured in radians) subtended by an infinitely distant object, divided by the length (measured in metres) of its image.

In these definitions, it is evident that every word has been carefully weighed. It would be advisable to adopt them generally, but they would clearly not usually be given to students in the earliest stages. We have not space to discuss them in detail, however, and we pass on to the question of conventions of signs

We may assign positive and negative signs to the distances of object and image from the reflecting or refracting surface according to a variety of schemes. The most common way is to treat these distances (s and s') as measurements made along the axis of symmetry of the instrument, so that the whole consideration is restricted to rays whose paths are near the axis. There are then five possible ways of allocating signs, denoted by group I. These are :

(1) The positive direction is the initial direction of progress of the light. (e. g. Robertson : " Introduction to Physical Optics ")

(2) The negative direction is the initial direction of progress of the light. (e. g. Watson : " Text book of Physics ")

(3) s and s' are positive when measured in opposite directions, the positive direction of s' being the positive direction of case (1). (e. g. Drude's " Theory of Optics ")

(4) As above, but the positive direction of s is that of case (1). (No books are known to use this convention)

(5) The signs are based on the Cartesian framework, and are independent of the direction of the light. (e.g. Houston: "Treatise on Light")

There is a further group of systems (group II) in which the conventions are of a different kind. The distances are measured, not along the axis, but actually along the path of the rays, so that we can obtain exact equations, even when the angles are no longer small. Four cases are possible, but only the following (case (1)) need be considered in practice. Positive signs are given to s and s' when they represent real rays, i.e., distances over which the light actually travels. Negative signs are given to distances over which the light does not actually travel, i.e., virtual rays. The convention is thus independent both of the Cartesian system, and of the direction of progress of the light.

The report recommends that for general purposes either the system of group I, case (1); or that of group II, case (1) should be adopted. They consider that the time has not come when it will be practicable to recommend the exclusive use of one convention, although, from many points of view, this would be desirable.

In considering the recommendations which have been outlined, we are concerned chiefly with the teaching of geometrical optics in its elementary stages. For the degree work, the student should have reached a stage where conventions of sign are of less importance. But for a stage of instruction represented, say, by the Intermediate examination of this University, it would appear that the second system recommended had great advantages, although at present it is very little used by teachers.

Firstly, the distinction between positive and negative distances has a physical significance which is easily appreciated by the student. Either the light does, or does not, traverse the path considered. No confusion can arise by turning the apparatus round, as in some of the Cartesian systems which involve the direction of progress of the light.

Secondly, it is just as simple to deduce the exact as the approximate equations, for as measurements are made along the rays one is not limited to paraxial rays. Any approximation introduced by assuming the angles to be small is made at the end of the calculation, not at the beginning. This gives a greater sense of reality to the whole procedure.

Thirdly, the system leads on to more advanced work, and to practical lens computing, as readily as any of the more customary conventions.

Fourthly, the system gives the same equation for mirrors and lenses, whereas the Cartesian systems give different equations. The equation is furthermore the simplest possible, namely :

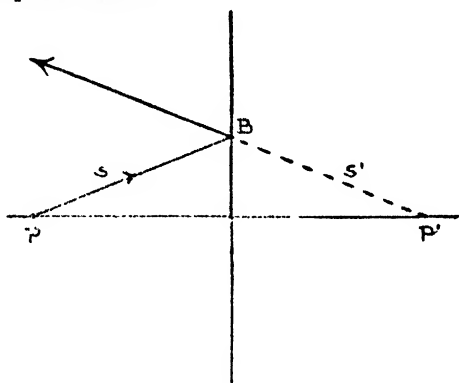
$$1/s + 1/s' = F$$

Finally, to illustrate the system, we may show how the standard imagery relation may be deduced in some simple cases. The law of refraction will be expressed in the form

$$n \sin \phi = n' \sin \phi'$$

It is highly desirable, in teaching, to present the law in this symmetrical form from the very beginning.

Reflection at a plane mirror



(Figure 1)

From the geometry of the figure

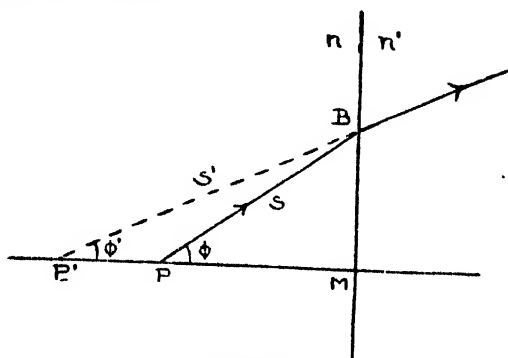
$$PB = P'B$$

$$\text{But } PB = s, P'B = -s'$$

$$\text{Hence } s + s' = 0 \text{ or, dividing by } ss'$$

$$1/s + 1/s' = 0$$

Refraction at a plane surface



(Figure 2)

From the geometry of the figure

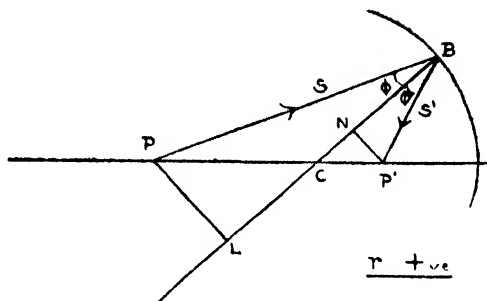
$$BM = PB \sin \phi = P'B \sin \phi'$$

But $PB = s$; $P'B = -s'$; $n \sin \phi = n' \sin \phi'$

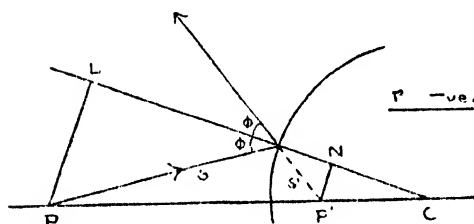
Hence $n's + ns' = 0$ or, dividing by ss'

$$n/s + n'/s' = 0$$

Reflection at a spherical mirror



(Figure 3)



(Figure 4)

Construction:—draw perpendiculars to the normal from the object and image points.

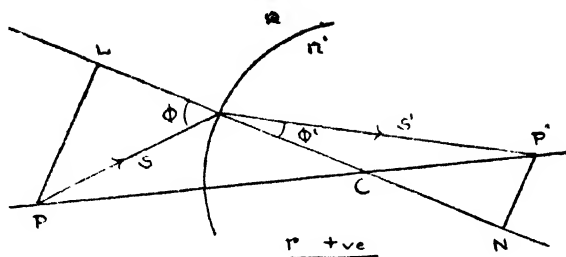
$$\text{Then } CL/PL = CN/NP'$$

$$\text{Or } (s \cos \phi - r)/s \sin \phi = (r - s' \cos \phi)/s' \sin \phi$$

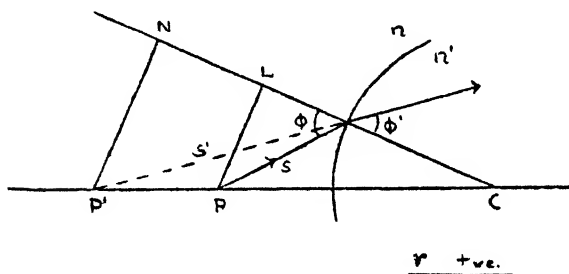
$$\text{Hence } 1/s + 1/s' = 2 \cos \phi / r = F$$

This is the exact equation: for paraxial rays we may now set $\cos \phi = 1$.

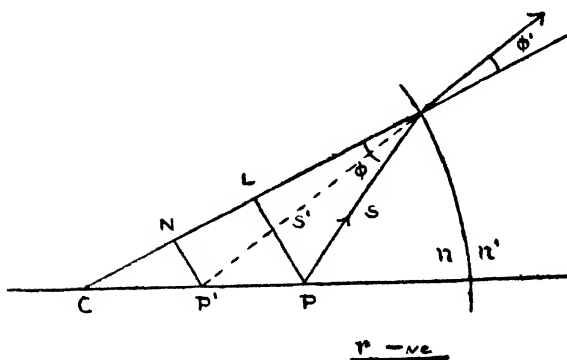
It will be seen that this derivation applies to both (indeed to all possible) figures.

Refraction at a spherical surface

(Figure 5)



(Figure 6)



(Figure 7)

Draw perpendiculars as before ;

then $CL/PL = CN/NP'$

or $(s \cos \phi + r)/s \sin \phi = (s' \cos \phi' - r)/s' \sin \phi'$

Hence $n/s + n'/s' = (n' \cos \phi' - n \cos \phi)/r = F$

Here again, we may set $\cos \phi = 1 = \cos \phi'$ for paraxial rays.

Refraction through a thin lens

Consider the two refractions separately. The first surface, if acting alone, would produce an image, which we may regard as the object for the second refraction. If this first image were real, it would lie beyond the lens and be equivalent to a virtual object for the second refraction. Conversely, if it were virtual, it would lie in front of the lens and be equivalent to a real object for the second refraction. Thus in either case, if s' be the image distance for the first refraction, $-s'$ is the object distance for the second refraction. Thus, if the final image distance after both refractions be s'' , we shall have

$$n/s + n'/s' = F_1 \text{ for the first refraction}$$

$$-n'/s' + n''/s'' = F_2 \text{ for the second refraction}$$

(The refractive indices for the first refraction are n & n' , for the second, n' & n'')

$$\text{Adding the equations, } n/s + n''/s'' = F_1 + F_2 = F$$

If the lens has air on both sides, we may write $n = n'' = 1$.

$$\text{Hence } 1/s + 1/s'' = F$$

Naturally the accuracy of this equation is limited by the condition we have imposed that the lens be thin. It is not difficult to develop exact equations for a thick lens.

Conjugate foci

We now see that the equation $1/s + 1/s'$ applies without change to mirrors and lenses, whether convex or concave. It is very simple to calculate a series of conjugate foci for all cases. Indeed the following table, where corresponding values are in the same columns, may be written down at once:

s	$+\infty$	$2f$	f	$f/2$	$+O$	$-f/2$	$-f$	$-2f$	$-\infty$
$1/s$	$+O$	$F/2$	F	$2F$	$+\infty$	$-2F$	$-F$	$-F/2$	$-O$
$1/s'$	F	$F/2$	O	$-F$	$-\infty$	$3F$	$2F$	$3F/2$	F
s'	f	$2f$	∞	$-f$	$-O$	$f/3$	$f/2$	$2f/3$	f

It is a useful exercise for the student to plot on a graph the corresponding values of s and s' , for various cases of mirrors and lenses, by giving F a series of positive and negative values.

There are, of course, other forms of the object-image equation, in which the measurements may be referred to the foci, or to the nodes, instead of to the surfaces. These other forms are quite easily introduced. The system also lends itself to calculating the formulæ for the longitudinal and transverse magnifications. Without going into such matters, enough has been said to demonstrate the simplicity and directness of the sign conventions which have been proposed.

It is to be hoped that physics teachers in the University generally will not ignore such a weighty contribution to the pedagogy of the subject as is represented by the Physical Society's report. We are at present, perhaps, far too dependent on text-books both for matter and method in Physics teaching. In Wilson College the conventions recommended are already being tried for elementary teaching. Only experience can show whether the arguments here advanced are sound. The sooner that experience is gained, the better.

TECHNIQUE OF THE FAR INFRA-RED INVESTIGATIONS.

Dr. N. R. TAWDE, Y. G. NAIK AND D. D. DESAI.

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Historical

Of recent years, the study of the spectral region known as the "far" and "near" infra-red has proved of much value in the investigation of molecular structure. No doubt the structure of a large number of compounds has of late been elucidated by newer methods of Raman spectra, yet substances not easily accessible to this procedure have to be attempted by infra-red methods. On account of the experimental difficulties involved in this kind of work, relatively few attempts are made to investigate the infra-red region. The infra-red, for purposes of experiment, falls into two divisions. The first which is called the near infra-red extends from $1\ \mu$ to $23\ \mu$, ($1\ \mu = 10^{-4}$ cms.) and the 2nd called 'far' infra-red covers region from $23\ \mu$ and onwards. This latter which generally gives a clue to problems of free rotation in a molecule has not been studied in so great a detail as the 'near' infra-red which covers vibration frequencies of a molecule superposed over its rotation frequencies. The near infra-red is more accessible to experiment because substances transparent to these radiations and ready-made prism spectrometers are easily available.

The experimental technique of the far infra-red is relatively very difficult on account of the lack of suitable material transparent to this region. The dispersion in this region is best achieved by means of a reflection or a wire-grating. Measurements with the help of wire-gratings, have been carried out in recent years by various investigators. The work of Rubens¹ in this connection in 1921, stands the foremost. Witt² was the next to use this type of apparatus successfully. Czerny's³ work on the study of rotation spectrum of HCl & Halogen derivatives in the far infra-red was a further milestone in the progress of these investigations. Leiss⁴ developed a refined apparatus using wire-grating. Barnes⁵ made many improvements in the existing technique of using wire-grating for this work.

INTRODUCTION

With a view to study the far infra-red region, the authors have been engaged for some time in setting up a wire-grating apparatus. During the course of the work, we have consulted all the available literature on the subject and have made use of it in setting up of the

present apparatus with slight modifications where necessary. It is therefore thought desirable to put on record a coherent and connected account of the work of various authors which has come within our reach and which has direct bearing on purely experimental aspect of the subject of far infra-red absorption spectra. This, in the light of experience gained by us, might serve as a compact reference guide to workers engaged in this field.

EXPERIMENTAL.

The most essential factors in the apparatus for the far infra-red measurements are (1) the source of continuous radiation, (2) the dispersing system, and (3) the detecting instruments.

These are shown in the following diagrammatic sketch.

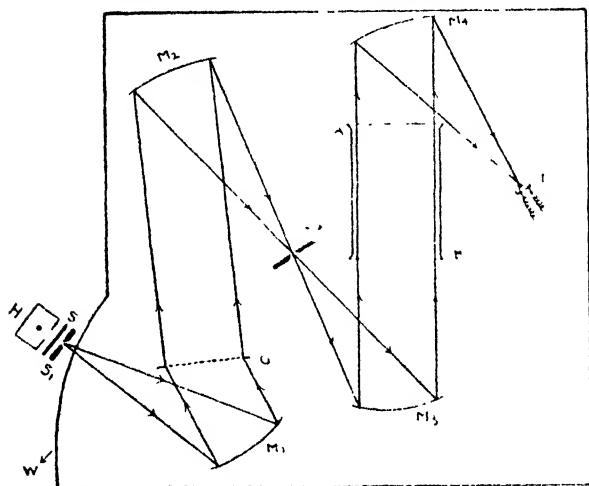


FIG. 1

Article 3: Technique of the Far Infra-Red Investigations by Dr. N. R. Tawde
Y. G. Naik and D. D. Desai.

H Globar Heater

S Shutter for cutting off the radiation

S₁ and S₂ Slits

W Celluloid Window

M₁, M₂, M₃ and M₄ Stainless Steel Mirrors.

G Wire-grating

A B Absorption Tube

T Thermopile with leads going to Galvanometer

For systematic treatment the subject is divided and explained under the following heads :

(1) Source of radiation.

- (2) Collimation of light.
- (3) Dispersion system (wire-grating) with special reference to the purity of spectra.
- (4) Slits.
- (5) Absorption Cells.
- (6) Apparatus for detecting the radiation.
- (7) Assemblage of the whole apparatus.

(1) SOURCE OF RADIATION.

Among the sources that give out appreciable radiation in the far infra-red may be mentioned the Welbach mantle, the Nernst filament and the globar heaters. Trials were given to each of these and ultimately it was found that globar heaters serve the purpose well. The Welbach mantle was found to have low energy of emission, and was liable to fluctuations owing to variation of gas pressure. Platinum coated with mantle foils and heated electrically was next tried but it did not serve the purpose better. Both these sources gave very weak radiations in the far infra-red and were undetectable by our instruments.

The Nernst filament which was next attempted was more efficient than the mantle lamp. As it takes a small current of 0.8 amp., a small variation in the strength of the current brings about a large alteration in the total energy of emission. The light transmitted through slit S_1 is also likely to suffer changes in magnitude and direction, as the thin filament has a tendency to bend at higher temperatures. Though the life-period of the filament is generally supposed to be of the order of 250 hours, it is liable to be damaged any time by a slight excess of current or by a sudden stoppage of it.

Finally we secured Globar heaters through the courtesy of the B. E. S. T. Company and have found them to be very satisfactory for our purpose. Globar heaters have been successfully used by—Rawlins and Taylor⁶ and by Strong⁷. The heating element is held between two special terminals provided with spring arrangement in one of them, to make allowance for expansion due to heat. The original heater required a large current and was therefore reduced in cross-section sufficient to attain brightness with a current of about 10 amps. This heater was found to possess the following advantage over the Nernst filament: (1) it does not require pre-heating; (2) its area of emission is greater which allows use of slits with large aperture; (3) it can be used without damage for an appreciable period; and (4) small fluctuations in a current strength of 10 amps. do not bring about a great change in the total energy emitted.

2. COLLIMATION OF LIGHT.

It should be remembered that for collimation of radiation, devices involving the use of most of the materials transparent to visible and near infra-red are out of consideration. The collimation of light has therefore to be effected by means of metallic mirrors made of stainless steel as it is found that they reflect more than 99% of the incident radiation. The mirrors M_2 , M_3 , M_4 , shown in the figure 1 are of 8 cms. diameter and 45 cms. focal length. The Mirror M_1 , is however of a large diameter of 16 cms. and the same focal length as above. This latter requires to be so, for the reason that when it is rotated, the whole grating surface should remain illuminated. Barker and Meyer⁵ have particularly laid stress on this point. The mirrors have fine independent screw movements for rotation about vertical and horizontal axis, which have been effected by the Junior Lab. Workshop, Poona, on specially prepared stands. Heavy loading at the base allows for their stability. The heater, the mirrors, grating and the thermopile have to be adjusted with their centres in the same horizontal plane. Astigmatism has been minimized after the manner shown by Czerny & Turner.⁹ The inclinations of mirrors with each other have to be as small as possible. The mirror M_1 rotates along with the heater so that angle, through which it rotates is the same as the angle through which the diffracted beam is deflected. The rotation of M_1 is necessary to select a particular band of the spectrum, which is brought into focus at slit S_2 . The rotating system ought to be able to turn without causing any mechanical disturbance to the other stable components. This, however, is not achieved in practice and so we propose to follow the arrangement of Barnes⁶, wherein he selects a particular band by the rotation of a single plane mirror placed behind the grating, the heater as well as mirror M_1 remaining fixed. The present arrangement is shown in fig. II.

3. DISPERSION SYSTEM.

This consists of a wire-grating, got specially prepared from the Laboratory of Prof. M. N. Saha, Allahabad. In its size of $2'' \times 1.5''$, the number of wires were 204 and its average grating constant was $\cdot 02515$ cms. This grating is capable of working upto the region 250μ . The angle of diffraction for the region 23μ to 250μ lies between 5° and 84° . The grating is also mounted on a stand and is capable of rotation about the vertical and horizontal axis. Grating is placed as near to the mirror M_1 as possible so that even for the large deflections of the mirror M_1 it remains completely illuminated. The position of the grating was so adjusted that the deflections of the galvanometer, when the mirror M_1 turned through equal angles from the zero position on either side of the grating, were equal. The Zero position of the

mirror was taken as that one, for which galvanometer gave the maximum deflection.

Purity of Spectra: There is always a chance of higher order spectra of the near infra-red overlapping the spectrum of far infra-red. It has been observed by Czerny³ and Barnes⁵ that a small % of the energy of 20μ , occurring as an impurity could easily produce a deflection of the same order as that produced by the total energy at 100μ in the first order. For this reason, the third order of 33μ and fifth order of 20μ at 100μ are dangerous. It is therefore necessary to eliminate the second and higher order spectra. The thickness of the wire is very approximately equal to half the grating constant so that the even order spectra were automatically eliminated. In order to see whether second and all even order spectra were really missing, yellow line of sodium was examined by means of the grating and it was found that the grating gave only odd order spectra. Owing to imperfection in the grating, however, traces of even orders of the near infra-red may be present. In order to eliminate these along with 3rd and higher orders of the near infra-red, various devices have been used by different workers, such as, Barker, Mayer, Sleater, Czerny and Barnes. Czerny uses soot deposited on paraffin to cut off the near infra-red. Barnes has made a series of experiments on the power of transmission of films of various types and finds that celluloid film having thickness 1μ and coated with deposit of camphor soot is quite good. It has about 80% transmission for wave lengths above 30μ . Barnes also gives a list of substances effective in giving restrahlen rays for a particular band of the spectrum. They are :—

Ca F ₂	from	20 μ to 30 μ .
Aragonite	from	30 μ to 40 μ .
NaCl	„	45 μ to 55 μ
KCl	„	55 μ to 70 μ .
KBr.	from	70 μ to 94 μ .
TiCl	„	94 μ to 134 μ .

We propose to use flourspar plate which absorbs all the far infra-red. The plate when brought into the path of rays will allow only the near infra-red and the deflections obtained will be eliminated from another set of readings taken without the plate. This procedure will enable deflection to be noted only for the far-infra-red.

4. SLITS (Fig. 1)

The slit s_1 (Fig. 1) serves as the object and s_2 is placed in order that only a particular diffracted beam will pass through it. The height of each of the slit openings was 3 cms. and preliminary observations have been taken with a slit width of 1.5 mms. In practice

however, it has been found necessary to work with various slit openings, to compensate for the weakening of intensity in the long wave-length regions. Barnes⁶ has given the following suitable slit widths for various portions of spectrum.

Regions.	Slitwidth.
30 μ to 85 μ	0.75 mm.
85 μ to 122 μ	1.25 mms.,
122 μ to 180 μ .	2.0 mms.

Large slit widths are objectionable on the ground that they reduce the resolution of bands. But the resolution is to be sacrificed here in order to enable measuring instruments to detect the radiation in the spectrum.

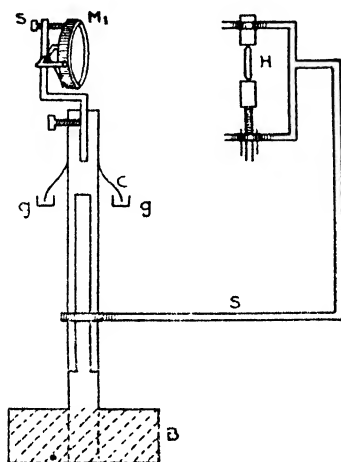


Fig. II

Fig. II.

Article 3; Technique of the Far-Infra-Red Investigations by
Dr. N. R. Tawde Y. G. Naik and D. D. Desai.

(Figure 2).

Figure 2.

- S Screw for tilting the mirror about horizontal axis.
- M Stainless Steel Mirror.
- C Metal Cup.
- g, g. Groove containing mercury.
- S Shaft attached to the rotating pillar.
- B Cement Base for the pillar.
- H Global Heater.

5. ABSORPTION TUBES.

The tubes are made of brass about 6" long and 3" in diameter. They are provided with stopcocks to allow gases to be filled in. The end openings are sealed with windows of transparent material. This

material should be of a very small absorption coefficient. Great difficulty is generally experienced in getting a suitable substance. Mica, quartz, cellulose, paraffin and Zapon lack films are among the materials that are found transparent to far infra-red radiation to various degrees, and have been used by different workers. We used paraffin and cellulose for preparing window films. Czerny³ and Kellner¹⁰ prepared films by spreading paraffin upon surface of glass covered with celluloid film and also on water surface. But they possess certain disadvantages as was found by Czerny and verified by us.

For achieving a better film in point of thickness and uniformity and some other factors, a film prepared upon mercury surface has been shown by us to be more efficient as reported in a recent communication.¹¹

For accurate and rapid measurements, two tubes are used with great advantage. Some radiation is necessarily lost by absorption through the windows and this has to be accounted for before proceeding with the measurements on the required substance. It is rather an inconvenient procedure to take an initial measurement with an empty tube and then another with the same tube filled. To avoid this, two tubes fixed with similar windows are mounted parallel to each other on a rotating wheel and by external contrivance, each one is brought in succession in the path of beam. This arrangement has been illustrated in Fig. 3.

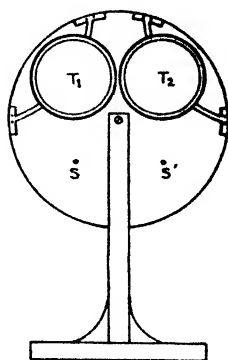


Fig. III

Fig. III.

Article 3 ; Technique of the Far Infra-Red Investigations, by
Dr. N. R. Tawde, Y. G. Naik and D. D. Desai.
(Figure 3).

T_1 and T_2 Absorption Tubes.

S and S' Stops for keeping the absorption tube in position.

6. APPARATUS FOR DETECTING THE RADIATION.

The Moll linear thermopile having 30 elements in a row is being used in conjunction with Pye moving-coil galvanometer for measuring the spectrum. It has been found fairly sensitive to weak radiations. Mounted on a bracket in a wall and separated from the thermopile by a distance of about 5 meters, the galvanometer was given sufficient immunity from mechanical disturbance by means of glass-paper packing below its base. In spite of these precautions the initial zero of deflection was found to be fluctuating for some reasons. The cause was traced to two factors. One was the adiabatic changes within the air space of the thermopile and the other due to heating of galvanometer junctions by the radiations from the slit illuminating its mirror. These were eliminated by enclosing the galvanometer completely in a cardboard box, leaving only a glass window for the beam of light. In the case of the thermopile, its opening was covered by a very thin film of paraffin. These precautions were found sufficient to maintain the zero of the galvanometer constant even during day-time.

7. ASSEMBLAGE OF THE WHOLE APPARATUS.

All the component parts (except the heater) shown in Fig. 1 were placed on a table (100×100 cms.) in their relative mapped positions. An enclosure was made for the whole top of the table in the form of a closed wooden box which had also to be made free from water-vapour and CO_2 before it could be used for any measurement. Precise arrangements were made to operate and observe by one person the rotation of mirror M_1 , the shutters and the absorption tubes, and to observe at the same time the galvanometer deflection. To avoid outside mechanical disturbances due to traffic and busy surroundings in the vicinity, readings are generally taken during night. The heater is switched on about $1\frac{1}{2}$ hours earlier so that only when all conditions have become steady, the observations are begun. Scrupulous care is taken to insulate the room and the surroundings of thermopile against external heat effects.

It must be acknowledged that the work was initiated by Mr. S. B. L. Mathur while he was in the Institute and we have to record our thanks to him for helpful suggestions in the early stages of the work. Our thanks are also due to Prof. Paranjpe for his constant encouragement and advice.

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THE PRESENT POSITION REGARDING THE THEORIES ABOUT THE NATURE OF ACTIVE NITROGEN

BY

C. R. DHODAPKAR.

In 1900 E. P. Lewis observed ^{2,7} that nitrogen could be stimulated by an electric discharge to emit a bright yellow glow which continued for some time even after the discharge had ceased. He photographed the infra-red portion of the spectrum and made a number of spectroscopic observations on the glowing nitrogen. Lord Rayleigh, who investigated the phenomenon in a more general and systematic way, discovered that the glowing gas had remarkable spectroscopic and chemical properties and named it 'Active Nitrogen'. Active Nitrogen could be produced in a number of ways. Kaplan¹⁰ produced it by passing condensed discharge through air at 0.5 m.m. Herzberg showed that it was possible to produce active nitrogen in which the percentage of nitrogen varied from 100 per cent. to 40 per cent. Hagenbach and Frey¹³ showed that glowing active nitrogen could be produced by passing condensed discharge through air at 10 m.m. The spectra observed by all these authors were the same as that obtained from active nitrogen that has been produced from almost pure nitrogen. It is, however, our experience that active nitrogen, as produced from almost pure nitrogen* is the most intense.

It may be mentioned, as a passing remark that a line spectrum due to the nitrogen atom is known, but is not shown by active nitrogen. Wien showed the emitting system of the nitrogen first positive bands to be uncharged. He allowed a stream of luminous gas to flow out of a canal tube into a space where a vacuum of the order 10^{-3} to 10^{-4} m.m. is continuously maintained by a number of diffusion pumps. In this space the gas is allowed to pass between two parallel plates which are maintained at a small distance apart at a constant difference of potential. The spectrum of the luminous slit-like region is photographed. Particles which are uncharged showed straight spectral lines, while lines due to charged particles are bent one way or the other. The vacuum in the space is so high that no collision takes place amongst the particles. Further Rayleigh was unable to con-

* The presence of a slight impurity is very essential for the production of active nitrogen.

dense anything which might indicate the existence of a body such as N_3 . It seems fairly certain therefore, that the characteristic luminescence is emitted by simple diatomic nitrogen molecules in some *unusual* State.

As has been said before, active nitrogen has remarkable spectroscopic and chemical properties. Its most conspicuous features are green, yellow and red bands*; the yellow ones, being usually the brightest, give the glow a yellow colour. The passage of a weak discharge through active nitrogen excites the fourth positive bands, but results, as was pointed out by Strutt, in the partial destruction of the afterglow. Heat has a peculiar effect on the afterglow. If a stream of glowing gas is passed through a tube which is moderately heated, the glow is locally extinguished, although it is still able to excite sodium atoms to the emission of the yellow doublet (¹¹, ¹², ¹⁸). If on the other hand, it is carried through a tube immersed in liquid air, it glows with increased luminosity. Active nitrogen reacts with metals, non-metals and compound bodies in a remarkable way. It excites the D and sometimes the green doublet of sodium, and also the line spectra of Cd, Mg, Hg, K, Zn, P, Th. It changes yellow phosphorus to red, forms a transparent green deposit with sulphur and reacts with several non-metals such as iodine, arsenic, etc. The reaction with nitric oxide is important; the gases interact with the production of a greenish flame, the evolution of heat and the formation of nitrogen peroxide and nitrogen. It develops the band spectra of compounds when they are vaporised in it, giving in many cases spectra of substances too unstable to be examined at the temperature of Bunsen flame. In fact this simplified development of the band structure constitutes a great advantage of active nitrogen over the arc or the spark in the study of band-spectra. It is true that the band system developed in this way often differs considerably in appearance from the same system developed in arc or spark on account of a radical change in the intensity distribution as regards both the intensity of the lines in each band and the relative intensities of the bands of the system. In its interaction with other substances, active nitrogen is able to transfer to atoms and molecules amounts of energy up to, but not exceeding, 9.4 though amounts up to 10.4 volts may be transferred under certain conditions.⁸

Various theories have been advanced to explain the nature of active nitrogen, and the mechanism of its formation and decay, but

* The system of bands referred to are the N_2 bands in the spectrum of active nitrogen belonging to the First positive System. $B^3 \pi \rightarrow A^3 \Sigma$. See Dr. Jevon's Report on Band-Spectra, P. 206.

as yet there is no theory which can explain all the characteristics, the properties, and the reactions of active nitrogen. The present is an attempt to throw some more light on this problem which still awaits a more satisfactory solution.

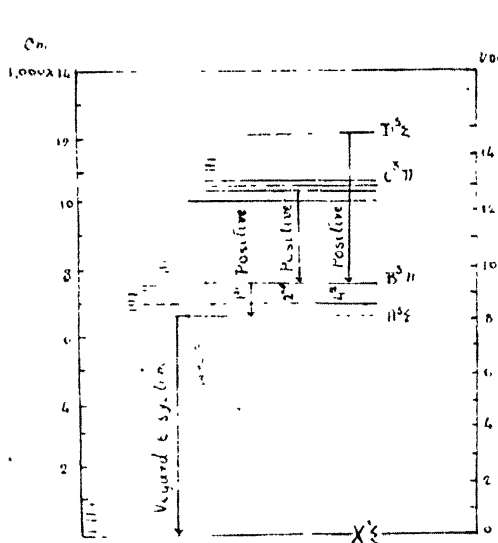
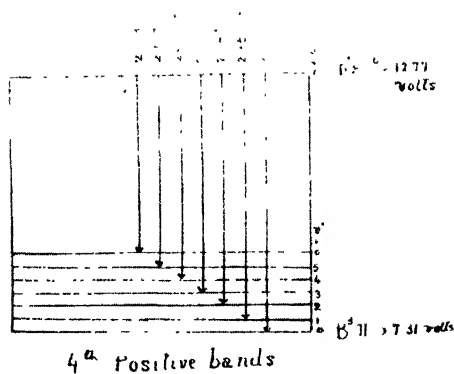
It has been said above that the presence of some impurity is essential for the production of active nitrogen. The emission of the spectrum of the afterglow is one in which nitrogen alone is concerned; the impurity simply plays the part of a catalytic agent, and is involved in no other way, for the spectrum is identical whether the impurity is oxygen, methane or any other gas.

We now come to the consideration of the mechanism by which active nitrogen is produced and suffers decay. We have obviously three possible views before us; (a) atomic nitrogen emerges from the discharge and then recombination takes place to give the molecules which are at an energy level high enough to give the known spectrum, (b) nitrogen atoms emerge from the discharge and in a triple collision that follows combine to form a normal molecule, the energy involved in the recombination process being utilised to excite a third partner, the normal molecule involved in the collision, to a higher energy level, (c) molecules of nitrogen excited in the discharge to a higher energy level are 'metastable'; that is, they have considerable life and can continue to exist for some time after leaving the discharge.

If we now assume (a) to be the possible mechanism, a spectroscopic difficulty arises, in that we should expect a certain amount of continuous spectrum as a result of the recombination of free atoms. There is yet another difficulty; unless the two atoms meet in a triple collision with a third molecule which can remove the energy liberated in the union of two atoms, there is every reason to expect that the energy so liberated in the recombination process would again break asunder the newly formed molecule into atoms. Thus if the mechanism involves the union of atoms into molecules, that recombination can take place only in triple collisions.

One of the main differences of the condensed and the uncondensed discharge in nitrogen is the excitation of the fourth positive group in the former, the null (0,0) band in this group requiring about 14.8 volts for its excitation. In order to obtain active nitrogen in any appreciable quantity, it is very necessary to use a condensed discharge. All the known fourth positive bands originate on the D level that has zero as its vibrational quantum number*. Bands arising on higher D levels have not been observed, suggesting that the binding in this state is so weak that dissociation

(*) Dr. Jevon's report on band-spectra, p. 77.



The figures on the right represent the values of excitation potential accepted until the discovery and interpretation of Vegard's A → X bands. They must be brought down by 2 to give the values at present accepted.

occurs quite readily. These facts suggested to Sponer the following hypothesis¹⁴ regarding the nature of active nitrogen. A discharge in which the molecules are on the brink of dissociation should according to Sponer abound in atoms. This and the long life of active nitrogen and its behaviour in the presence of catalysts suggest with reasonable certainty that active nitrogen is composed of normal atoms and molecules. The characteristic visible afterglow is emitted as a result of triple collision between two atoms and one molecule; the energy liberated during the recombination process of two atoms is in many cases sufficient to raise the third partner to the vibration level corresponding to quantum number twelve of the B state. Dr. Sponer's estimate of the dissociation energy¹⁴ was 11.5 volts, the energy which is necessary to excite these bands. But it is now difficult by her theory to account for the afterglow bands, as the work of dissociation of the nitrogen molecule has recently been estimated at about 7.34 volts* (the figure now accepted by all). Secondly her theory is unable to explain the exceptional enhancement of the bands corresponding to vibration quantum numbers 11 and 6 in the upper $B^3\pi$ state.

Before we go on to consider the mechanism (c), we will just consider the selection rules for electronic transitions for band-systems. They are

- (i) Change of $S=O$ usually or ± 1 less frequently; i. e. change of multiplicity = O usually, or ± 2 less frequently.
- (ii) Change of $\lambda = O$ or ± 1 ; Change of $\Sigma = O$.
- (iii) Change of λ for 'emission' electron = O or ± 1 .
- (iv) Of the three conceivable transitions between three given electronic states, all may take place in a compound molecule, but not more than two in an elementary molecule.

This extra restriction in the case of elementary molecules was interpreted by an application of the quantum mechanics. The elementary states of an elementary molecule are classed theoretically as "even" or "odd" according as the sum of the individual l -values for all electrons is even or odd, exactly as in the case of atomic states. Transitions occur only between states of opposite character, $g \rightarrow u$ and $u \rightarrow g$, and this rule, which is exactly the same for atoms, applies rigorously to elementary molecules. The molecule which emits the afterglow bands is N_2 , an elementary molecule. The N_2 states X, A, a, B and C are classed as $X'\Sigma g, A^3\Sigma u, a^1\pi u, B^3\pi g$, and $C^3\pi u$ respectively. The observed system $C \rightarrow B$ (2nd positive), $B \rightarrow A$

* Sponer and Herzberg determined the value of dissociation energy to be 734 volts (Zeits für Phys-Chem 26 B, 1, 1934) although the accuracy of their result is questioned by Appleyard, Thomson and Williams (Nature 134, 322, 1934). The figure 73 is now strongly supported by Maier-Leibnitz and Sponer (Z P 89, 431, 1934), Mulliken (P R, 46, 144, 1934) and Büttnerbender and Herzberg (Ann der Phys, 21, 577, 1935) and some of Kaplan's 1934 notes.

(first positive) and $A \rightarrow X$ Vegard's Σ system, are all according to this selection rule. But A is a triplet level, while X is a singlet level. The transition $A \rightarrow X$ is very feeble because of the inter-multiplicity. A is thus a metastable state to a certain extent.

Further from the Hund theory, we can predict the lowest three terms of atomic nitrogen to be 4S , 2D , and 2P , where 4S term is a normal one, and 2D and 2P are metastable states. The difference $^2D-^4S$ is found from Hopfield's data on the ionization limit of $N\ I$ to be 2.37 volts. The difference $^2P-^4S$ has been interpreted from the spectrum of $O\ II$ and is found to be 3.56 volts.

Cario and Kaplan¹⁸ considered that beside normal atoms and molecules, active nitrogen contains non-vibrating metastable molecules in the $A^3\Sigma$ state corresponding to an energy of 8.2 volts* in addition to two kinds of metastable atoms in 2D and 2P states corresponding to energies of 2.37 and 3.56 volts respectively. They explain the special enhancement of the bands corresponding to quantum numbers 11 and 6 in $B^3\pi$ state as a result of collision between metastable atoms and the metastable molecules, for the energies necessary to excite these bands are very nearly equal to 11.5 (8.2+3.56) and 10.5 (8.2+2.37) volts respectively. With this theory the 'dark modification' which can still excite D lines of sodium, the emission of the afterglow bands, as well as other properties could be satisfactorily explained.

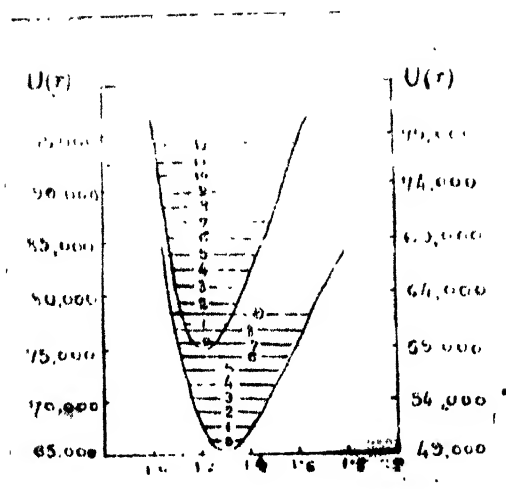
Assuming that in active nitrogen, metastable molecules and metastable atoms occur at proper concentration, the so-called resonance effect in the metallic spectra should be expected to occur, that is to say the lines corresponding to an excitation energy greater than that of the metastable molecules (8.2 volts) will be extremely weak in comparison with those which have their excitation energies equal to 8.2, 2.37, and 3.56, or smaller than 8.2. The more intense the lines appear, the nearer their excitation energies to 8.2, 2.37, 3.56, volts. No special enhancement of such lines was observed in the metallic spectra observed by several experimenters.

POTASSIUM †

Line observed	Excitation energy	Remark.
1^2S-4^2P	3.58	No special enhancement.
2^2P-4^2D	3.38	"
2^2P-3^2S	3.38	..

* State $A^3\Sigma$ was at that time supposed to have electronic energy of about 8.2 volts, but has recently been shown to have only 6.14. The state $B^3\pi$ has therefore 7.31 volts.

† The Science Reports of the Tohoku Univ. vol. 21, No. 4, p. 557, 1932.



Approximate potential energy curves for $A^1\Sigma$ and $B^1\Pi$ States of N_2 .
 On the right are given the values now accepted of potential energy for $A^1\Sigma$
 and $B^1\Pi$ states of N_2 ; on the left are the values accepted until the
 discovery and interpretation of Vegard's $A \rightarrow X$ bands.

Caesium†		
Line observed	Excitation energy	Remark.
1^2S-5^2P	3.42	"
2^2S-6^2P	3.55	"
2^2P-6^2D	3.43	"
2^2P-7^2D	3.56	"
Mercury†		
2^3P-2^1S	7.89	"

It is to be concluded from the above that as there is no evidence of resonance enhancements, the concentrations of such metastable atoms and molecules, if they exist at all in active nitrogen, is negligible. On the other hand, it is generally observed that in active nitrogen, lines of lower excitational energy appear, without any exception, to be more intense than those of higher excitational energy, and that the decreasing rate of the intensities of the lines with the increase of term number is more rapid in this case than in any other case of excitation (^{3,4,6}). Again the long life of active nitrogen which is its important feature cannot be explained by the existence of metastable atoms and molecules. Besides from the results of exhaustive experiments carried out by Herzberg¹⁶, Kneser,¹ Warede¹⁷ Bay and Steiner²¹ it is at present generally accepted that active nitrogen is composed of nitrogen atoms and that its main properties are natural consequences of its atomic nature.

J. Okubo and H. Hamada⁹ accepted Spomer's hypothesis regarding the nature of active nitrogen, namely that active nitrogen is composed of normal atoms and molecules. They have made, however, two assumptions to explain the observed results and properties of active nitrogen. They assume in the first instance that in the vibrational states with $v'' = 8$ in the metastable $A^3\Sigma$ state and that corresponding to $v' = 6$ in the upper $B^3\pi$ state, the near-nuclear turning points have the same nuclear distance as the nuclear separation between the nuclei in the normal $X^1\Sigma$ molecular state. Secondly they assume that with the exception of neutral unexcited atoms and molecules, molecules corresponding to quantum numbers 7 or 8 of the metastable $A^3\Sigma$ state are the most numerous. With these assumptions, they suggest that the nitrogen molecules are excited to the required energy levels in two steps, the first being the excitation to the metastable $A^3\Sigma \sim^8$ state and the second to the $B^3\pi \sim^{11}$ and $B^3\pi \sim^6$. Most of the properties of active nitrogen can then be explained by this modified view.

It is however doubtful if the two assumptions made have really the experimental backing they need. The Morse function that they have used to find the near-nuclear distances gives the values very

† The Science Reports of the Tohoku Univ. vol. 21, No. 4, p. 557, 1932.

approximately. Secondly it will also be seen from the diagram that the potential energy curves for $B^3\pi$ and $A^3\Sigma$ states on the left hand side run almost steep and it will be equally accurate to say that the nuclear distances for some quantum numbers other than 8 for the $A^3\Sigma$ state and those for some quantum numbers other than 6 for $B^3\pi$ state are equal to the nuclear separation of the nuclei in normal $X^1\Sigma$ state. Further J. Okubo and H. Hamada take it for granted that the dissociation energy of the nitrogen molecule in the $X^1\Sigma$ state is greater than the excitation energy for the $A^3\Sigma \sim^8$ state. The exact determination of these energies is very necessary, since their values are nearly equal to each other. Their whole hypothesis falls to the ground, if it be shown that the energy of the $A^3\Sigma \sim^8$ is greater than the energy of dissociation.

G. Cario²⁰ who with Kaplan¹⁸ had assumed the existence of metastable molecules and metastable atoms to explain the emission bands of active nitrogen now considers that active nitrogen is atomic in nature and recombination of two normal nitrogen atoms to molecules is possible only in triple collision. Molecules so produced are in an excited metastable state. Collision between two such molecules gives rise to a metastable 2P atom and normal 4S atom, or two atoms in the 2D state and a normal molecule in each case. These metastable atoms collide with metastable molecules raising them to higher energy levels from which they emit the afterglow bands.

The arguments advanced for the production of metastable molecules and metastable atoms are worthy of careful attention. Cario accepts 7.34 volts as the value of the dissociation energy as determined by Sponer and Herzberg¹⁹, and 6.14 volts as the value of the ground level of the A state as against 9 and 8.3 volts respectively. So far as the mechanism of the emission of the afterglow is concerned the quantitative data do not matter, although it may be remarked that the accuracy of these data is questioned by some experimenters⁶ and supported by many others. To follow Cario then, two normal atoms and one normal molecule meet in a triple collision. In their recombination process, they liberate 7.34 volts of energy which raises the molecule to $A^3\Sigma \sim^7$, or to $A^3\Sigma \sim^0$. In the latter case the difference (7.34-6.14) will be used partly by the old and partly by the new molecule to change their translation energy. Metastable atoms are produced by collision of two metastable molecules. For a 2P atom the reaction would be

Volts.	Volts.	Volts.	Volts.	
6.14	+	6.14	=	7.3
				+
				3.56
				+ a small part.

The small amount of energy which remains unaccounted for would be used up by a 2P atom to change its translation or vibrational energies. For a 2D atom,

$$6.14 + 6.14 = 7.3 + 2.37 + 2.37.$$

In this case a very small amount would be left for changing the translation or vibrational energies.

It will be seen from the above reactions that in the collision between metastable molecules the number of ^2D atoms produced on an average should be twice as great as the number of ^2P atoms produced. Interpreted spectroscopically this means that in the spectrum of active nitrogen, bands from $\text{B}^3\pi\sim^6$, $\text{B}^3\pi\sim^5$ etc. should be more intense than those arising from $\text{B}^3\pi\sim^{11}$ etc. This is quite in contradiction to the observed distribution of intensity in the afterglow, where, bands arising from $\text{B}^3\pi\sim^{11}$ being the most intense, ^2P atoms must obviously be the more abundant of the two. This constitutes clearly a contradiction between experience on the one hand and theory on the other. Cario's present hypothesis is still open to the objection that no impact resonance in metallic vapours is experienced, in spite of the production of metastable atoms and molecules in the process.

It will be clear from the foregoing pages that although there is no doubt as to the atomic nature of active nitrogen, the special enhancement of the bands arising from $\text{B}^3\pi\sim^{11}$ state is still inexplicable. Of the two assumptions made by J. Okubo and H. Hamada, one at least has now the experimental backing after the determination of dissociation energy at 7.34 volts by Sponer and Herzberg which is greater than the excitation energy for $\text{A}^3\Sigma\sim^8$. As has been shown before, their other assumption is still very unconvincing, and as such the special enhancement of the bands arising from $\text{B}^3\pi\sim^{11}$ state cannot be explained, as they claim, on the Franck-Condon principle. We could, of course, see from Cario's theory that the bands arising from $\text{B}^3\pi\sim^{11}$ and $\text{B}^3\pi\sim^6$ should be more intense than those arising from other levels of $\text{B}^3\pi$ state. But looking to the portion in which the metastable atoms in the ^2P and ^2D states are produced according to Cario's theory, the bands arising from $\text{B}^3\pi\sim^6$ should be the most intense—a conclusion falsified by experiment. Cario's theory is still open to the objection, that in spite of the production of the metastable molecules and metastable atoms in triple collisions, no impact resonance in metallic vapours is experienced.

It has been said in the beginning that the presence of foreign matter is very essential for the production of active nitrogen. It

Part played by foreign matter. therefore yet remains to consider the part thus played by the small proportion of foreign gases in its production. We have seen that the afterglow bands are due to the N_2 molecule alone. The impurities play no part in the actual light emission process. Their function must therefore be in

some way to accelerate the formation of atoms into excited molecules in the discharge, or to retard the spontaneous reversion of the active nitrogen which, in their absence, may be very rapid indeed. The work of Wood and Bonhoeffer in their investigation on hydrogen and the process of chemiluminescence provides us with a suitable analogy which, when applied to active nitrogen, probably explains the point in question. Wood and Bonhoeffer have shown that in a discharge tube filled with slightly impure hydrogen, the gas is completely dissociated in those parts of the tube which are far from electrodes, and can be pumped in a monoatomic form by a fast pump into a connecting tube. The walls of the tube cause a catalytic recombination of hydrogen atoms into molecules, and the impurities in the gas such as oxygen etc. act so as to hinder the catalytic recombination of atoms into molecules by the walls of the tube. The 'impurities' in nitrogen could have an exactly similar effect in preventing the destruction of atomic nitrogen in a 'useless' wall reaction.

SUMMARY.

1. A short account is given of the properties and phenomena of active nitrogen and also of the different methods of producing it. It is shown that the first positive system, $B^3\pi \rightarrow A^3\Sigma$ is due to N_2 molecule.

2. Three possible views of the mechanism by which active nitrogen is produced and suffers decay are discussed. It is now admitted that active nitrogen is atomic in nature, but none of the two theories discussed in the article explains convincingly the special enhancement of the bands arising from $B^3\pi \sim^{11}$ state.

3. An account is given of probable part played by foreign matter which is essential for the production of active nitrogen.

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A NOTE ON INTERPOLATION—FORMULAS.

By

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So many different formulæ for Interpolation are come across in a text-book that one is led to feel that each of them has some special feature and utility of its own. There is, for example, the Newton-Gregory's (or simply Newton's) formula for equal intervals of the argument and Newton's and Lagrange's ones for unequal intervals. Besides there are several central-difference formulas associated with the names Gauss, Stirling, Bessel, Everett, etc. As the fundamental principles on which these are based are the same, one would expect the same degree of accuracy from all and it is the object of this article to show that this is really the case. The special claims for accuracy that are advocated by a number of authors in favour of the central-difference formulæ over the Newton-Gregory formula can thus be seen to be ill-founded. On the other hand, the simplicity of form of the latter places it in advantageous position as compared with the former. I would therefore suggest that only two fundamental formulas, viz. those of Newton, one for equal and the other for unequal intervals of the argument, be laid emphasis on and used by *practical* statisticians and computers together with the working rule pointed out later in this article. (See Whittaker and Robinson's *Calculus of Observations* or the formulas and bibliography on the subject).

All interpolation formulas are derived from the following principles.

(i) The difference (or divided difference) of n -th order is constant (or practically so) and the subsequent differences are zero (or practically zero); the value of n depending on the function to be interpolated.

(ii) A polynomial of degree n is the simplest equivalent function.

(iii) The interpolation formula is this equivalent polynomial which exactly assumes the same values as the given function for the $(n+1)$ given values of the argument; and this is *supposed to be nearly equivalent* to the given function for all intermediate values of the argument.

Now, a polynomial of degree n , viz.

$$y = a_0 + a_1x + a_2x^2 + \dots + a_n x^n$$

has $(n+1)$ constants as coefficients and so, *one and only one* polynomial can be obtained which will have given values for $(n+1)$ given values of x . Or, putting it graphically, one and only one curve of n -th degree can be made to pass through $(n+1)$ given points of the function to be interpolated, that is, whose abscissæ represent the given values of the argument and ordinates the corresponding values of the function. It means that the graphs of the so-called different interpolation formulas must be identical. Hence the results of calculation from the various formulas must be identical too.

Next comes the important question of determining the region of the range (or interval) of the argument for which the equivalence of the polynomial with the function shall be the greatest possible. Before one can come to a satisfactory conclusion on this point, it is necessary to go over the process of deduction of an interpolation formula.

As the graph of the function to be interpolated is not known, only its values for some isolated values of the argument being known, the object of interpolation is to obtain an approximate form of the same which would be as accurate as possible. Since the given values of the function lead to the constancy (or practical constancy) of the n -th difference,—the value of n being obtained by actual calculation of the differences, one can see that in this respect the function behaves as a polynomial of n -th degree. Advantage is taken of this similarity in assuming that the polynomial will *very approximately* represent the function for the intermediate values of the argument. In other words, it is assumed that the graph of this polynomial would very approximately be the graph of the function in this range. There is no other valid ground for making this assumption except perhaps that of “simplicity”, viz. that of the graph of the polynomial being the algebraically simplest curve which can be drawn through $(n+1)$ given points. In the case of absolute constancy the polynomial can be identified with the function in question.

Now, the degree to which the graph of the polynomial will approach the unknown graph of the function depends on the range or the interval within which the given values of the argument are distributed. It has been found from the actual study of a number of known graphs in relation to those of polynomials that

- (1) the smaller the interval the greater is the approximation ; and
- (2) the closeness is most marked, in general, near the middle of the whole interval.

One can therefore safely assume that the same will be true for interpolation as well. That is,

(1) the smaller the given range of the argument the nearer is the approach of the polynomial to the function in question; and

(2) the nearest approach is, in general, near about the middle of the whole interval.

One must not forget the case when absolute constancy of the n -th difference is not forthcoming. In this case the degree of approximation of the interpolation formula will be less satisfactory than in the other one. This will be the lesser if the fluctuation in the values be greater. But here also the approximation will be the closest possible near about the middle of the whole interval.

The remark of the preceding paragraph also applies to the case when the formula is not proceeded upto that order of difference which is constant. One thus arrives at a simple *working rule* about all interpolation formulas, viz. *that the best results are obtained near the middle of the complete interval taken into consideration*. The central-difference formulas automatically take this into account; but the Newton's formula is bound to give the same result if the value to be interpolated be taken near the mid-range. An illustration is given below in support of this assertion.

The following example is selected from Whittaker and Robinson's *Calculus of Observations*, page 41, because it has already been demonstrated there that the answer as calculated with the help of all central-difference formulas is the same and equal to 0.0283 8498 7557, correct upto twelve decimal places. It only remains to show that the Newton's formula leads to the same answer.

Ex. To compute the value of $\log_{10} \cosh 0.3655$ from the following table:

Argument	Function	Δ	Δ^2	Δ^3	Δ^4	Δ^5
0.360	0.0275 5462 3980					
0.362	278 5523 7805	30061 3825				
0.364	281 5737 9665	30214 1860	152 8035			
0.366	284 6104 7438	30366 7773	152 5913	-2122	-13	
0.368	287 6623 8989	30519 1551	152 3778	-2135		10
0.370	290 7295 2180	30671 1391	152 1640	-2138	-3	

As the differences upto the fourth order are, in the first instance (same as in the book), to be included in the calculation the corresponding polynomial must be of the fourth degree also, and must pass through five points. It is therefore necessary to omit one of the six given values and two results will be obtained according as the

first or the last five values are chosen. The corresponding Newton's formula is

$$f(a+xw) = f(a) + x\Delta f(a) + \frac{x(x-1)}{1\cdot 2}\Delta^2 f(a) + \frac{x(x-1)(x-2)}{1\cdot 2\cdot 3}\Delta^3 f(a) + \frac{x(x-1)(x-2)(x-3)}{1\cdot 2\cdot 3\cdot 4}\Delta^4 f(a)$$

Taking the first five values, one gets

$a = 0.360$, w (or the equal interval) $= 0.002$, and so

$$xw = 0.3655 - 0.360 = 0.0055;$$

whence $x = \frac{55}{20} = \frac{11}{4}$. Therefore,

$$\begin{aligned} f(0.3655) &= 10^{-12} \times \left[(275\ 5462\ 3980) + \frac{11}{4} (30061\ 3825) \right. \\ &\quad \left. + \frac{77}{32} (152\ 8035) - \frac{77}{128} (2122) + \frac{77}{2048} (13) \right] \\ &= 10^{-12} \times [283\ 8498\ 7556.94] \dots (1) \\ &= 0.0283\ 8498\ 7557, \end{aligned}$$

upto twelve decimal places. This is in agreement with the other results.

If, however, the last five values are chosen instead of the first five, one would have

$$a = 0.362, w = 0.002 \text{ and } x = \frac{35}{20} = \frac{7}{4}.$$

Therefore

$$\begin{aligned} f(0.3655) &= 10^{-12} \times \left[(278\ 5523\ 7805) + \frac{7}{4} (30214\ 1860) \right. \\ &\quad \left. + \frac{21}{32} (152\ 5913) + \frac{7}{128} (2135) - \frac{35}{2048} (3) \right] \\ &= 10^{-12} \times [283\ 8498\ 7557.12] \dots (2) \\ &= 0.0283\ 8498\ 7557 \end{aligned}$$

as before.

If one desires to take all the six values of the Table into account the term involving the fifth order difference in the Newton's formula is to be added as well. This will add .09 to the number in the square brackets in (1) giving the result as

$$10^{-12} \times [283\ 8498\ 7557.03] \dots (3)$$

It is of great interest to compare the results of calculation as given in the book (loc. cit.) upto fourteen decimal-places. These are

- (i) Everett's formula 0.0283 8498 7557 03,
- (ii) Bessel's formula 0.0283 8498 7557 02,
- (iii) Gauss's formula 0.0283 8498 7556 95,
- (iv) Stirling's formula 0.0283 8498 7556 94.

The difference in the last two figures of the above four results and that of (1) is due to the fact that in Gauss's and Stirling's formulæ (from which the calculations are made) as well as in (1), the term involving the fifth order difference is not taken into account; whilst that term is partially included in Bessel's formula and wholly in Everett's during the process of deduction of these formulas. The necessary corrections are 09 for each of the first three mentioned above and 01 for Bessel's; these bring the results equal to (3) in every case except Gauss's. The reason for the defection in the case of Gauss's formula might be adduced to some error in calculating the proper figure for the last place. Such concurrence in the results given by the various formulas is really to be expected since all central difference formulæ are deduced from Newton's formula for unequal intervals. And since the Newton's formula for equal intervals is merely a particular case of that for unequal intervals, and a central difference formula is for equal intervals too, one can expect a direct deduction of the latter from the Newton's formula for equal intervals. One method is based on Fraser's Lozenge Diagram. As an illustration of another but similar method, let us deduce Everett's formula viz.

$$\begin{aligned}
 f(a+xw) = & \left[\zeta + \frac{\zeta(\zeta^2-1)}{3!} \right. \\
 & + \frac{\zeta(\zeta^2-1)(\zeta^2-4)}{5!} \delta^4 + \dots \left. \right] f(a) \\
 & + \left[x + \frac{x(x^2-1)}{3!} \delta^2 \right. \\
 & + \frac{x(x^2-1)(x^2-4)}{5!} \delta^4 + \dots \left. \right] f(a+w) \dots (4)
 \end{aligned}$$

where $\zeta = 1-x$ and $\delta^2 f(a) = \Delta^2 f(a-w)$, $\delta^4 f(a) = \Delta^4 f(a-2w)$ etc., from the Newton's formula

$$f(b+xw) = f(b) + x \Delta f(b) + \frac{x(x-1)}{2!} \Delta^2 f(b) + \dots \dots \dots (5)$$

Let us assume that the difference of order $2r$ is constant and form the following table:

Argument for Newton's formula	Argument for Everett's formula	Function	Differences
b	$\frac{a-rw}{a-r-1w}$	$f(b)$ or $f(a-rw)$	...
$b+rw$	$a-r-1w$	$f(b+rw)$ or $f(a-r-1w)$	...
...
...
$b+r-1w$	$a-w$	$f(b+r-1w)$ or $f(a-w)$	...
$b+rw$	a	$f(b+rw)$ or $f(a)$	...
$b+r+1w$	$a+w$	$f(b+r+1w)$ or $f(a+w)$	...
...
...
$b+2rw$	$a+rw$	$f(b+2rw)$ or $f(a+rw)$	...

Here we have $a = b + rw$. Substitute this in the right-hand side of (4) and expand the various terms in terms of $f(b)$ and differences of $f(b)$ with the help of the Newton's identity and the associated ones, (since x happens here to be integral)

$$\Delta f(b+xw) = \Delta f(b) + x \Delta^2 f(b) + \frac{x(x-1)}{2!} \Delta^3 f(b) + \dots \quad (6)$$

$$\Delta^2 f(b+xw) = \Delta^2 f(b) + x \Delta^3 f(b) + \frac{x(x-1)}{2!} \Delta^4 f(b) + \dots \quad (7)$$

etc. Collecting terms we get

the coefficient of $f(b) = (1-x) + x = 1$;

the coefficient of $\Delta f(b) = r(1-x) + (r+1)x = (x+r)$;

the coefficient of $\Delta^2 f(b) = \frac{(x+r)(x+r-1)}{2!}$ on simplification;

and so on. Hence the right-hand side of (4)

$$= f(b) + (x+r) \Delta f(b) + \frac{(x+r)(x+r-1)}{2!} \Delta^2 f(b) + \dots$$

$$= f(b+xw+rw), \quad \text{by Newton's formula}$$

$$= f(a+xw)$$

since $a = b + rw$.

In conclusion I assert once more that Newton's formulas, one for equal and the other for unequal intervals of the argument, are the best ones to be used for interpolation, and that they should be used to interpolate near about the middle term. The central-difference formula of Gauss or Stirling or Bessel would also give the same result provided one writes down *all possible terms* as would be known from the difference Table. Everett's formula would give as good a result if only the number of values of the argument given in the Table is *even* as had been the case in the example considered in this paper; otherwise the result deduced will be inferior to those of the other formulas.

A CRITICAL SURVEY OF THE VALENCY-DEFLEXION HYPOTHESIS

By

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The Valency-deflexion Hypothesis which is associated with the names of Professor J. F. Thorpe and Professor C. K. Ingold was put forward to explain the numerous discrepancies in the relative ease of formation and stability of the various ring systems on the basis of Baeyer's Strain Theory. A glaring instance of the failure of the Strain Theory of Baeyer is afforded by the experiments of Stohmann and Kleber (J. Pr. Chem. 1892 (11), 45, 475) on the heats of formation of simple homocyclic rings. The values of heat of absorption found by these investigators are at variance with the deduction of the Strain Theory.

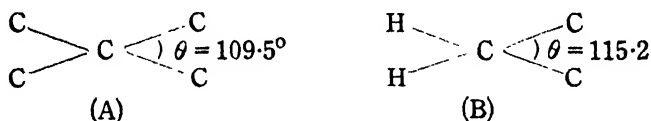
Ring.	Cyclopropane.	Cyclobutane.	Cyclopentane.	Cyclohexane.
Angle of Strain Baeyer	24.7°	9.7°	0.7°	5.3°
Heat absor- bed in cals, (S & K)	38.1	42.6	16.1	14.3

If we plot the curves of instability, the thermal data indicates that Cyclobutane should occupy the crest of the curve, while, according to Baeyer, the Cyclopropane ring should possess the greatest instability. Secondly the Cyclohexane ring is the most stable, according to the thermal figures, while this place should be occupied by the Cyclopentane ring. Moreover, the difference between the thermal data for Cyclohexane and Cyclopentane is very small, while Baeyer's Strain Theory leads us to expect an appreciable difference in stability between them.

In spite of a large amount of experimental work stimulated by this theory, general experience supports the validity of the results of Stohmann and Kleber rather than the Strain Theory. Thus it has been found that the methods which give Cyclopropane, Cyclopentane

and Cyclohexane rings with the greatest ease, break down absolutely in the case of Cyclobutane ring. Moreover, there is an overwhelming amount of data in literature to show that the stability of the Cyclopentane and Cyclohexane rings is of the same order.

In order to explain this discordance, Ingold (J. C. S 1921, 305) assumed that the tetrahedral angle of Baeyer (109.5°) was only valid when the tetrahedron representing the Carbon atom was attached to four Carbon atoms (A). However, in the case of polymethylene rings, we are dealing with a secondary carbon atom (B). Now, as the investigations of Kopp, Traube and others have shown that the hydrogen atom in organic compounds occupies a smaller volume than the carbon atom, the two carbon atoms attached to the central one occupy more of the surrounding space than the two hydrogen atoms in the methylene group. In that case, the angle between the carbon atoms of the methylene group will not be 109.5° , as supposed by Baeyer, but something greater than this. Further, allocating a spherical domain, the cubic content of which is proportional to the atomic volume of the element, to each of the four atoms of the polymethylene group, and using the Traube values of atomic volumes of the carbon and hydrogen atoms (Ahren's Vortrage, 1899, 4, 255), and making other assumptions, Ingold calculated that this angle θ must be 115.3° , and not 109.5° , as hitherto assumed.

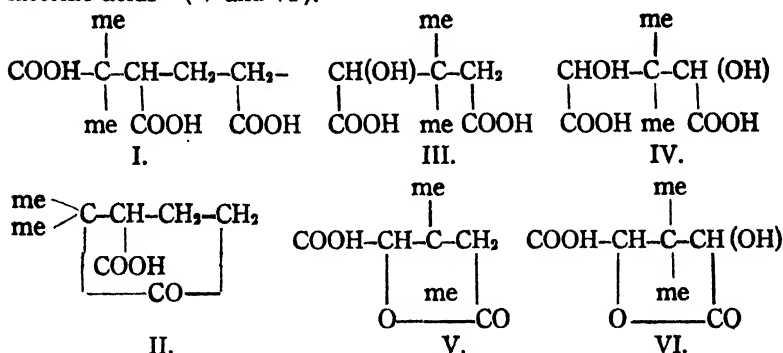


On the basis of this new value, it is possible to calculate by how much the terminal Carbon atoms of normal propane and butane chains must approach one another to form cyclopropane, and cyclobutane rings. The "Approach values" thus obtained are as follows and are in keeping with the thermal data of Stohmann and Kleber.

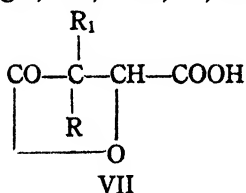
Cyclopropane.	Cyclobutane.	Cyclopentane.	Cyclohexane.	Cycloheptane.
0.345	0.427	0.220	0.207	0.730

The effect of gem-grouping in promoting ring formation is known in literature from the synthetical work of a large number of investigators. Thus Perkin and Thorpe (J. C. S. 1904, 85, 138) found that α - α -dimethylbutane α - β - δ -tricarboxylic acid (I) gave smoothly the cyclopentanone derivative (II) merely on boiling its sodium salt with acetic anhydride, while simple adipic acid did not undergo this change. α -hydroxy and α - α' -dihydroxy glutaric acids are stable substances, whereas the corresponding derivatives of β - β dimethylglutaric acid (III and IV) cannot be

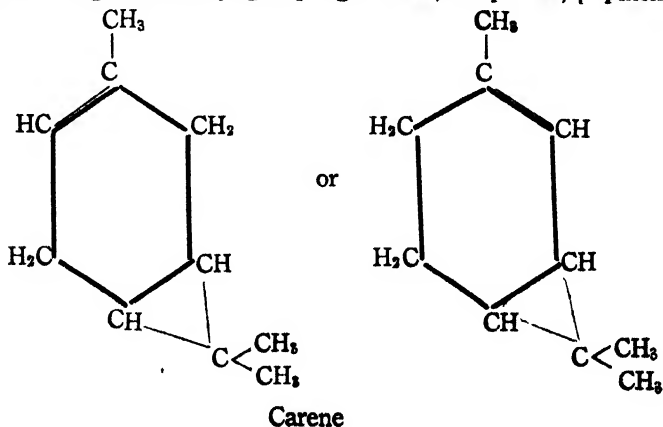
isolated in free condition owing to their tendency to pass into lactonic acids—(V and VI).

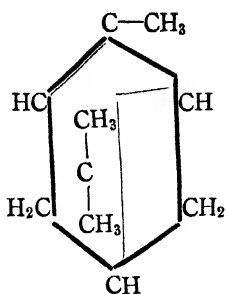
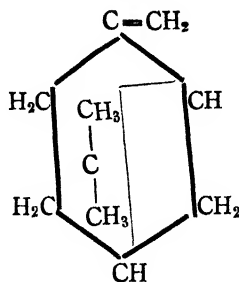


Glutaric anhydride is easily decomposed by water; β - β -dimethylglutaric anhydride may be boiled with water without much apparent change, whilst β - β - α -trimethylglutaric anhydride can be crystallised from hot water. (Perkin and Thorpe, J.C.S. 1899, 75, 65). A good number of β -lactones (VII) containing the gem-dialkyl groupings have been recently isolated (Kandiah, J.C.S. 1932, 1215; also Beyer and Villiger, Ber, 1897, 30, 1955).



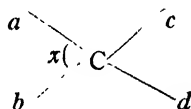
Among the naturally occurring essential oils, a large number of products contain the highly strained cyclopropane and cyclobutane rings, but the inherent strain of these compounds is relieved by the presence of a gem-dimethyl group e.g. carene, α -pinene, β -pinene.



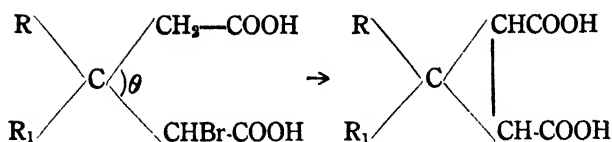
 α -pinene β -pinene

Camphor and Camphene also contain a gem-grouping, but simple monocyclic terpenes like limonene, α terpeneol, sylvestrene, pulegene, carvone etc. do not contain this grouping.

All these facts can be plausibly explained by the valency Deflexion Hypothesis which assumes that when a normal angle between the two valencies a and b of a carbon atom is changed either through their attachment to heavy groups or their inclusion in a ring complex, the angle between the valencies c and d undergoes a corresponding change in the opposite direction. Thus if the angle x becomes greater than normal angle 109.5° , the angle θ will be smaller than this amount, with the result that the groups attached to the valencies c and d will converge to one another.



The experimental support to this hypothesis has been given by so much amount of work that it is impossible to refer in details to all the work published by Thorpe, Ingold and their collaborators. (Beesely, Ingold and Thorpe, J.C.S. 1915, 107, 1080; Ingold and Thorpe, Ibid, 1928, 1320; Ingold, ibid, 1921, 305, 951 etc; Gane and Ingold, Ibid, 1928, 1954, 2267; 1929, 691; 1931, 2553. Qudarati Khuda, Ibid, 1929, 1913; 1930, 206 etc. S.S.G. Sircar, Ibid, 1927, 600, 1252, 1257; 1928, 898. K. A. N. Rao, Ibid, 1929, 1954; 1930, 1164. A. Kandiah, Ibid, 1931, 952). However, it is necessary to refer briefly to the three lines of evidence brought forward. (1) The work on the formation and stability of spiro-compounds formed by the removal of HBr from the two acetic acid residues of β - β -disubstituted glutaric acids as follows.



The results tabulated below show that as the value of θ decreases, the stability of the spiro-acids increases.

R R ₁	Angle θ	Stability of the spiro-acids
Me, Me	109.5°	Rapidly decomposed by 5% HCl at 200°
Cyclopentane	109.7°	Rapidly decomposed by 5% HCl at 200°
Cycloheptane	107.2°	Unaltered by conc-HCl at 240°
Cycloheptane	109.5°-y where y is small	Decomposed by 20% HCl at 240°
Trans-decalin	109.5°-x where x is small	Decomposed by 10% HCl at 240°

(Cf the Annual Reports of the Chemical Society, 1930 page 155).

But the most important evidence brought forward by Thorpe and his co-workers was the study of the tautomerism of various α -keto- β - β -disubstituted glutaric acids to the isomeric hydroxy-ring acids in presence of 64% potash. It was definitely shown that the percentage of the ring hydroxy acid in the equilibrium mixture increased as the angle θ decreased.

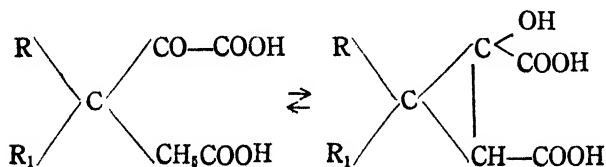


Table II shows the relation between angle θ , and the percentage of the ring hydroxy acid in the equilibrium mixture.

Table II

R R ₁	Angle θ	Percentage of the ring hydroxy acid	K ₁ at 25° $\times 10^5$
H, H,	115.3	0	4.69
Me, H	109.5	0	6.00
Et, H	?	0	5.29
Cyclopentane	109.7	0	17.3
Me, Me	109.5	0	19.8
Me, Et	109.5-x	0	24.4
Et, Et	109.5-y	62	33.9
Pr, Pr	109.5-z	71	33.9
Cyclohexane	107.2	100	33.4

The physical evidence of the dissociation constants of the various β - β -disubstituted glutaric acids (Spiers and Thorpe J. C. S. 1925 127, 538) is based upon the assumption that the greater the proximity of the two carboxyl groups to one another, the greater is the enhancement of the primary dissociation constant (K_1). The value of these dissociation constants have been shown above in table II.

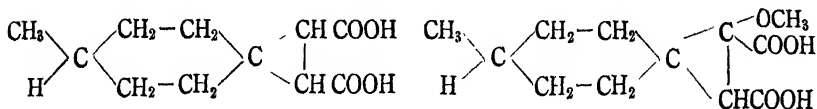
So far, we have discussed only one side of the *valency deflexion* hypothesis. Even during the early days of this hypothesis, a suggestion was raised that the effects of the associated groups and rings could be explained by some cause other than that of the valency-deflexion, such as the repulsion of electrically similar alkyl groups. But this objection can be waived aside when one takes into consideration the facile ring-closure of methyl diacetylsuccinic ester, where one of the methyls of the *gem*-dimethyl grouping is replaced by the carboethoxy group, whereas the unmethylated analogue does not undergo this change (Willstatter and Clarke, Ber, 1914, 47, 298,). Moreover, Lanfear and Thorpe (J. C. S. 1923, 123, 1683) found that the effect of the cyclopentane ring on the carbon tetrahedral angle was similar to that of *gem*-dimethyl group. On the other hand, if

valency-deflexion did not take any part, the effect of the cyclopentane ring should resemble that of the *gem*-diethyl group. The results obtained by Desai (J. C. S. 1932, 1065) in the decomposition of the mono- and dibromo-esters of 3-methylcyclopentane—1:1—diacetic acid showed that the methylcyclopentane ring bore the closest similarity to the cyclopentane and *gem*-dimethyl group, and not to the *gem*-ethyl-propyl group, which should be the case if valency deflexion was ruled out.

W. Hückel has severely criticised this hypothesis in a long memoir (Fortschritte der chemie, Physik und Physikalischen chemie, 1927, 19, 4.) disputing many of the fundamental assumptions of this hypothesis, but the authors have defended their original position (Ingold & Thorpe, J. C. S. 1928, 1318). Moreover, Huckel's memoir does not advance any constructive criticism in the form of an alternative hypothesis, which can satisfactorily collate all the data before the valency-deflexion hypothesis is given a knock out. Bennett and Chapman (Annual Reports of the chemical Society 1930, 155) are inclined to favour the opinion that a number of facts explained by the valency deflexion hypothesis can be ascribed to steric hindrance, especially the hydrolysis of the esters, the opening up of the lactones and the imides in which the screening effect of the substituents may be the principal factor. Short (Chem. News 1926, 133, 149) has pointed out that the "*Approach values*" calculated from the Beyer value of θ (109.5°) agree with the thermal values of Stohmann and Kleber (Loc. cit) as well, as those calculated from Ingold's values of θ (115.3°). The absence of any single relation between the angles of strain, and the "*Approach values*" calculated from the Ingold value for θ has been pointed out by Gunjekar and Wheeler (J. Ind. Chem. Soc. 1932, 9, 87).

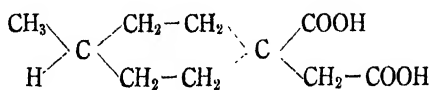
Finally, it is instructive, in this connection, to refer to the work of the author on the effect of the methylcyclohexane ring on the carbon tetrahedral angle on the basis of the valency deflexion hypothesis. It was observed that unlike the cyclohexane ring, it simulated the behaviour of the strainless rings like cyclopentane and trans-decalin. (Desai, J. C. S. 1932, 1047). That the mere introduction of a methyl group should have such a profound effect in eliminating strain is really curious and puzzling, and two explanations alone are possible. The methylcyclohexane ring may have become stabilised in the strainless form; but during the course of the investigation, all the efforts to isolate the isomeric spiroacids (VIII and IX) did not meet with any success. There used to be in literature, one instance of the isolation of four strainless isomeric forms of 4-methylcyclohexane—1—carboxy—1—acetic acid (X) by Qudarti Khuda (J. Ind.

Chem. Soci 1931, 8, 277), but repetition of this work by the author and Dr. R. F. Hunter here in this Laboratory (in the press) has shown the existence of only two forms, and we have been independently supported in our conclusion by Goldschmidt and Grüfinger (Ber. 1935, 279).



VIII.

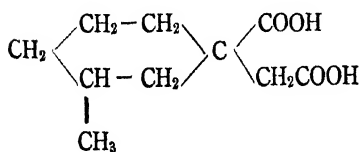
IX.



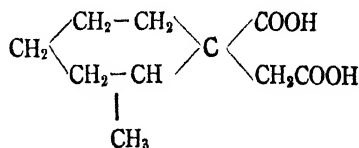
X.

Moreover, our attempts to obtain the four isomeric strainless forms of 3-methylcyclohexane —1—carboxy—1—acetic acid (XI) and 2-methylcyclohexane —1—carboxy—1—acetic acid (XII) resulted in the isolation of only two forms (in the press). We hoped for better luck in the isolation of two strainless forms of 3:3-dimethylcyclohexane—1—carboxy —1—acetic acid (XIII) where the *gem*-dimethyl group would stabilise the strainless forms, but we could get only one.

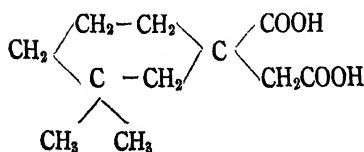
Finally, our exhaustive work (in the press) on the isomeric forms of 1—cyano—1—arylamino—4—methylcyclohexane, (XIV) and their 3—methyl— and 2—methyl— analogues convinces us that the methylcyclo—hexane and cyclohexane rings are similar in spatial configuration.



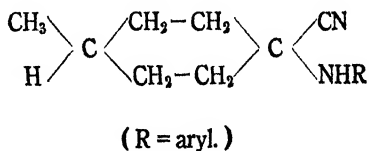
XI



XII



XIII.



(R = aryl.)

XIV.

To support this conclusion, there is another physical evidence in the form of the comparison of the primary dissociation constants of 3- and 4 methylcyclohexane, cyclopentane, and cyclohexane-1:1-diacetic acids. (Ives, Linstead and Riley, J. C. S. 1932, 1093) which are shown here under.

Acid	K_1 at $25^\circ \times 10^4$
Cyclopentane - 1:1 - diacetic acid	1.76
Cyclohexane - 1:1 - diacetic acid	3.23
3 - methylcyclohexane - 1:1 - diacetic acid	3.25
4 - methylcyclohexane - 1:1 - diacetic acid	3.21

The conclusion is unavoidable that the chemical methods used to demonstrate strain in cyclohexane, cyclopentane and other rings are invalid in the case of the methylcyclohexane ring. The author believes that it is not presumption on his part to say that these methods have been found wanting, in spite of their successful application in the previous cases, and that an ideal chemical method has yet to be discovered.

Summaries and Abstracts of Theses for the M. Sc. degrees.

- 1.—“*Dielectric Properties of Some Vegetable Oils.*” By Mr. P. Y. DESHPANDE. for the M. Sc. degree of the Bombay University. (Royal Institute of Science.)

The density, the refractive index and the dielectric constants at room temperature (26°C) are determined for the solutions of castor oil, olive oil, sesame oil, and coconut oil in benzene. The dielectric constants are determined at 30 meters (10,000 k. c.) by observing resonance with the help of a valve-voltmeter. The method of solution is used to establish the dipole character of the oil molecules and to determine the values for their polarizations and electric moments by the application of the Debye equation for dilute solutions of polar substances in non-polar solvents.

It is found that in very dilute solutions, the molecules of these oils are more or less free from association though at higher concentrations the association effects are predominant. Experiments on very dilute solutions of these oils therefore give fairly reasonable values for their electric moments which are in this case 3.678×10^{-18} , 3.030×10^{-18} ,

2.914×10^{-18} , and 2.821×10^{-18} for respectively castor oil, olive oil, sesame oil and coconut oil.

- 2—*Transmission of light through homogeneous clouds.* By Mr. N. N. BHAGWAT for the M. Sc. degree of the Bombay University (Royal Institute of Science, Bombay)

The work was undertaken to verify Stratton and Houghton's theory of the transmission of light through clouds of water.

The paper gives a method of analysis for the verification of the above theory and describes suitable experimental arrangements for obtaining the necessary data.

The results obtained with water are discussed in detail and are found to agree tolerably well with the theory, with all its limitations.

In order to obtain information about the influence of refractive index on transmission, six other typical liquids were also examined. Transmission curves for different wave lengths were found closer together in the case of lighter liquids but no definite conclusions could be arrived at as

regards the effect of the refractive index.

Two of these liquids showed good agreement with the theory; one liquid showed only a partial agreement; and the remaining three exhibited no agreement whatever.

3.—*Artificial vibrations of the ground.* By MUKUND DINKAR MANOHAR for the M. Sc. degree of the Bombay University. (Colaba Observatory, Bombay.)

When a known weight is dropped from a known height we communicate a definite energy into the ground. We can calculate the vibrations produced in the ground, assumed to be isotropic, by an impulse of this kind and compare them with the observed results. The ground movements at various distances from the source of disturbance were recorded by two horizontal components 'N. S. and E. W.' seismographs of the Milne Shaw type. (period twelve seconds, damping ratio 20 : 1 and a vertical component seismograph (period 3.6 seconds,) all locally constructed. All the three components were recorded on the same sheet of photographic paper kept quickly moving by clock-work. The movement in all the three components begins with a sudden impulse and is followed by oscillations having compound periods composed of the free periods of the small building in

which the instruments are housed and the forced periods of the ground due to the dropping of the weight. The amplitude of the horizontal component of the ground movement is found to decrease with distance approximately according to the theoretical law (distance)^{-1/2}. The periods of the forced movement of the ground depend on the duration of impact and the elastic constants of the ground; and the theoretical values agree fairly closely with the observed values. When a weight of 12.7 kilogrammes meets the ground with a velocity of 4 M/s, the amplitude of the horizontal component of the ground movement at Colaba is about 12 μ at a distance of 10 metres and 5 μ at 20 metres and the period of the forced vibrations is about 0.05 sec. The free period of the building is 0.014 sec.

4.—*Evaporation and its measurements.* By NARAYAN VASUDEO KOGEKAR for the M. Sc. degree of the Bombay University. (Bombay and Poona Observatories).

Guide : Dr. S. K. Banerji.

In continuation of the work on the subject by S. K. Banerji and H. M. Wadia (Memoirs of the India Meteorological Dept. Vol. XXV Part IX 1932) further experiments were carried on at Poona mainly with the object of studying the behaviour of the layer

next to the evaporating surface. For this purpose an evaporation tank ($2' \times 2' \times 1\frac{1}{2}'$) with the usual water channel all round was placed in a closed chamber with an arrangement for varying the radiation by an electric heater with parabolic reflector. A large number of open scale thermometers (dry and wet bulb) were arranged with axial symmetry and with their bulbs at various heights above the water surface. Thermometers were also installed for recording water temperature; a black bulb in vacuo was used for taking measurements of the radiation. An eye-reading evaporimeter was also observed at the same time. Starting with a known sample of air observations were taken with (1) water temperature varying, air temperature remaining constant, (2) water temperature constant but air temperature varying, (3) both water and air temperature varying. The observations indicate the existence of a layer of depth varying from 3 to 6 cms. according to the intensity of radiation and temperature of water, next to the evaporating surface with properties different from those of the layers above. These properties have been plotted and analysed in the paper. Records have been taken of the air movements above the evaporating surface by means of smoke lines. Some continuous records of evaporation in the open were also taken. These have been discussed in the paper.

AB

5.— *β -hydroxy-ethyl ethers of substituted phenols and related substances.* By D. C. MOTWANI and T. S. WHEELER. A summary of the thesis submitted by Mr. Motwani for the M. Sc. degree of the Bombay University. June 1934, (Royal Institute of Science.)

PART I. *β -hydroxy-ethers of substituted phenols.*

Part I deals with the condensation of ethylene chlorhydrin with resorcinol, *m*-methoxy phenol, resacetophenone, and 4-ethyl resorcinol, and derivatives of the products. The resultant hydroxy ethyl ethers of the type R. O. CH_2 . CH_2OH , where R = substituted or unsubstituted benzene nucleus, may be antiseptics.

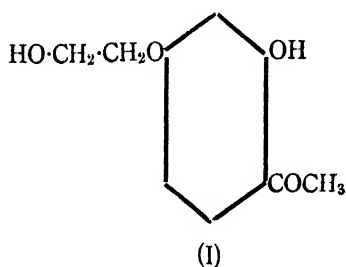
Rindfus, Ginnings, and Harnake (J. A. C. S. 1920, 42, 157) condensed ethylene chlorhydrin with resorcinol in presence of sodium ethylate and obtained 1:3 di (β -hydroxy-ethoxy) benzene. The condensations have now been effected by dissolving the phenol in aqueous potash and refluxing the solution with ethylene chlorhydrin. The modification is noteworthy in that, in the case of insoluble ethers, the completion of the reaction is marked by the aqueous layer losing its colour which is initially red. It was observed that the heat of solution in the case of resacetophenone and 4-ethyl resorcinol affected the yield and isolation of the end-product. For this reason

these phenols were dissolved in alkali in presence of ice.

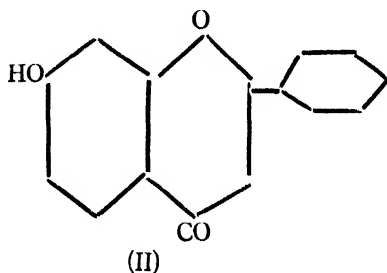
Resorcinol gave (a) *m*-(β -hydroxyethoxy phenol and (b) 1:3 di (β -hydroxy-ethoxy) benzene of which the former is new. The di-ether was obtained in purer state m. p. 95-96° Rindfusz (loc. cit.) gave 81°.

m-methoxy phenol gave *m*-methoxy (β -hydroxy-ethoxy) benzene which is a liquid.

Resacetophenone gave only 2-hydroxy-4 (β -hydroxy-ethoxy-) acetophenone (I).



Its constitution was fixed by the alcoholic ferric chloride coloration and the synthesis of 7-hydroxy flavone (II)



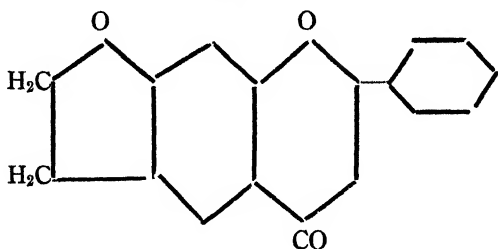
m.p. 240° (Robinson and Venkataraman J. 1926, 2, 2344). The alkali soluble benzoyl derivative of the ether separated as a gel from the usual organic solvents.

Alkali insoluble phenols were obtained from the ketone-ether. They were, the *azine*, the *anil*, the *phenylhydrazon*, and the *benzidine* condensation product HO. C₂H₄OC₆H₃ (OH). C (CH₃). NC₆H₄. C₆H₄NH₂. All these were insoluble in dilute aqueous alkalies (Cf. Adams, J.A.C.S. 1919, 41, 247). The reasons for this insolubility are still obscure and the phenomena are rendered still more difficult to explain by the observation now made that certain phenols though insoluble in dilute alkalies, dissolve when they are suspended in strong alkali and the system diluted with water. The ketone ether on reduction with zinc-amalgam gave 2-hydroxy-4 (β -hydroxy-ethoxy) ethyl benzene.

4-ethyl resorcinol gave (a) 2-hydroxy-4 (β -hydroxy-ethoxy, ethyl benzene) in a predominating yield and (b) 2:4 di (β -hydroxy-ethoxy) ethyl benzene. (a) was identified with the reduction product of I.

Part II. Condensation of 2-hydroxy-4 (β -hydroxy-ethoxy) acetophenone with aromatic aldehydes; an attempt to synthesise dihydrofuran flavone.

Part II describes an attempt to synthesise substances containing fused coumarane and γ -pyrone nuclei: dihydrofuranflavones (III).



(III)

The methods employed consisted in starting with either a coumarane or a flavone and introducing either the flavone or coumarane ring. The attempts in this direction did not lead to a successful synthesis of a dihydrofuran flavone, as coumarane derivatives could not be obtained. Some flavone derivatives have been prepared and studied. The starting materials chosen were the mono- β -hydroxy-ethyl ethers of resacetophenone and *m*-methoxy phenol.

(I) was condensed with benzaldehyde and the 2-hydroxy-4-(β -hydroxy-ethoxy) chalkone converted by Kostanecki's method (Ber. 1898, 36, 1757) via diacetoxy-chalkone-dibromide into 7-(β -hydroxy-ethoxy) flavone which on de-ethylation passed into (II). Direct bromination of 2-hydroxy-4-(β -hydroxy-ethoxy) Chalkone introduced a bromine atom into the nucleus and the bromo derivative when hydrolysed yielded 7-(β -hydroxy-ethoxy)-6-bromofla-

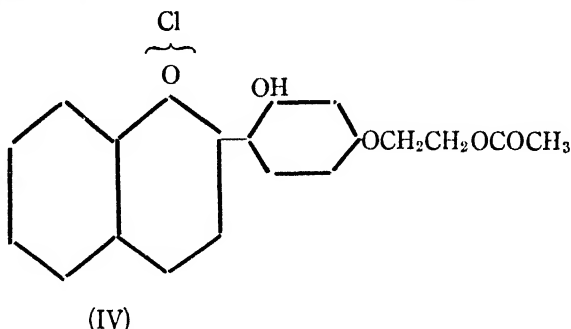
vone and not the isomeric benzylidene-coumaranone (cf. Cullinane and Phillipot J. 1929, II, 1761). The constitution of the

compound was arrived at by its colourless solution in concentrated sulphuric acid (Cf. Perkin & Everest; "The Natural Organic colouring matters" p. 164.) The compound on treatment with phosphorus pentabromide gave 7-(β -bromo-ethoxy)-6 bromoflavone.

(I) was condensed with O. nitrobenzaldehyde when corresponding chalkone was obtained and not a lactyl ketone (Cf. Clasién Ber, 1881, 14, 2470; Baeyer & Drewsen Ber, 1882, 15, 2856, and Price & Bogert J. A. C. S. 1934, 56, 2443). It was found that the sunlight affects the yield and the isolation of the chalkone and hence the condensation was carried out in absence of white light.

(I) was also condensed with anisaldehyde and salicylaldehyde when the corresponding chalkones were obtained. 2-hydroxy-4-(β -hydroxy-ethoxy)-4-methoxy-chalkone derived from anisaldehyde passed according to Kostanecki's

method (loc. cit.) via the *diacetoxy chalcone dibromide* into 7-(β hydroxy-ethoxy)-4 methoxy-flavone, and 2-2': dihydroxy-4 (β hydroxy-ethoxy) chalcone derived from salicylaldehyde, afforded, 2'-hydroxy-4' (β acetoxy-ethoxy) flavylum chloride (IV)



Cyclisation of the hydroxy ethyl ethers of resacetophenone, *m*-methoxy phenol and of substituted flavones with the help of anhydrous zinc chloride and phosphorous pentoxide according to the method of Rindfus (loc. cit.) could not be accomplished and coumarane derivatives were not produced. Similarly negative results were obtained when 7- β (bromo-ethoxy)-6 bromoflavone was subjected to the action of sodium in anhydrous xylene.

T. S. W.

6—*Synthetic Production of Camphor from Pinene.* By B. G. S. ACHARYA, and T. S. WHEELER, A summary of the thesis submitted by Mr. Acharya for the M. Sc., degree of the Bombay University (July 1934), Royal Institute of Science, Bombay.

This work was undertaken to find a suitable process for the manufacture of camphor from pinene obtained from turpentine. A close search of the academic and technical literature was made and many of the proposed processes were tested in the labora-

tory with systematic control of the experimental conditions. Not only have the conditions proposed been examined, but improvements have also been made since patentees often refrain from stating the best conditions. Besides, an entirely new process has been discovered for the direct oxidation of camphene to camphor.

The technical preparation involves five stages. Pinene is converted by treatment with hydrogen chloride into pinene-hydrochloride. This on removal of hydrogen chloride yields camphene. It is then esterified with an organic acid to yield isobornyl ester, and hydrolysed by alkali when the secondary alcohol, isborneol is obtained. This is finally oxidised to yield the ketone camphor.

Throughout the work the ne-

cessity of using cheap chemicals has been kept in mind, and the possibilities of replacing chemicals given in patents by cheaper reagents of the same type have been systematically investigated.

B. G. S. A.

7.—*Bromination of esters containing two Aromatic Nuclei*

By G. V. JADHAV and Y. I. RANGWALA. A summary of the thesis submitted by Mr. Rangwala for the M.Sc. degree of the Bombay University (July 1934). Royal Institute of Science, Bombay.

The work is divided into two parts :

PART I treats of the bromination of cresyl and nitro-phenyl esters of benzoic acid. The constitution of bromo-cresyl esters which was left undetermined by Kauschke (J. Pr. 1895, (2), 51, 213) has been fixed by hydrolysis and synthesis. In these esters, bromine enters in the cresyl nucleus giving mono-bromo compounds while in nitro-phenyl esters, it enters in the unsubstituted acid nucleus giving mono- and dibromo-compounds. The deactivating effect of the $-\text{NO}_2$ group on these esters is strong, as a powerful carrier, namely, fuming nitric acid (sp. gr. 1.45), is required to bring about the bromination.

PART II treats of the bromination of phenyl and cresyl

esters of m- and p-nitro benzoic acids. With simple phenyl esters, only mono-bromo compounds are obtained. With the cresyl-esters mono-, di-, and tri-bromo compounds are obtained. In all these cases bromine always enters in the phenyl and the cresyl nuclei, showing thereby a complete deactivating effect of the $-\text{NO}_2$ group on the acid nucleus. The constitution of these bromo-esters is determined by hydrolysis and synthesis.

The following compounds were obtained in this investigation:—

4-bromo-2-methyl- and 4-bromo-3-methyl-phenyl benzoates ; 2-bromo-4-methyl-phenyl benzoate ; o-nitro-, m-nitro, and p-nitro-phenyl-m-bromo-benzoates ; o-nitro-, m-nitro-, and p-nitro-phenyl-2 : 5 dibromo-benzoates ; p-bromo-phenyl-p-nitro-benzoate ; p-bromo-o-cresyl- and p-bromo-m-cresyl-p-nitro benzoates ; 4 : 5 dibromo-o-cresyl-p-nitro-benzoate ; 3 : 5 dibromo-p-cresyl-p-nitro-benzoate ; 3 : 5 : 6 tribromo-p-cresyl-p-nitro-benzoate ; p-bromo-phenyl-m-nitro-benzoate ; 4 : 5 dibromo-o-cresyl-m-nitro-benzoate ; 3 : 5 : 6 tribromo-o-cresyl-m-nitro-benzoate ; 4 : 6 dibromo-o-cresyl- and 2 : 6 : 4 dibromo-p-cresyl-p-nitro-benzoates ; and 2 : 3 : 6 : 4 tribromo-p-cresyl-p-nitro-benzoate.

Y. I. R.

8—*Suitability of some Indian Bauxites for the Production of*

Alumina. By M. S. PATEL AND G. K. OGALE. A summary of the thesis submitted by Mr. Ogale for the M. Sc. degree of the Bombay University (Feb. 1935), Royal Institute of Science, Bombay.

The investigation was undertaken to furnish the data necessary to work out a scheme for the manufacture of alumina from Indian bauxite.

Samples of bauxite from various places were collected and analysed. The results show that bauxite rich in alumina occurs at Radhanagari and Tungar (Bombay Presidency) and at Tikaria and Katni (Central Provinces). Their titanium content is also very high.

Attempts to find out a suitable concentration of either HCl or H_2SO_4 to remove the iron present in bauxite without dissolving the alumina resulted in failure.

Digestion of bauxite with a caustic soda solution of sp. gr. 1.42 under pressure at 160°C for 6 hours was found to be most suitable for the determination of alkali-soluble alumina.

Fusion with sodium carbonate at 900°C for one hour also gave nearly the same results as the alkali digestion.

Samples of bauxite containing a high percentage of alkali-soluble alumina were subjected to Bayer's process and the yield of alumina

and the alkali used up during the treatment were determined. It was found that bauxite from Radhanagari, Tungar and Katni is quite suitable for the production of alumina by this process.

The residues, obtained after treating the various samples of bauxite, were found to contain 20 to 36% TiO_2 calculated on dry basis. This high titanium content may prove of great value to the Indian aluminium Industry.

G. K. O.

9.—C-Alkyl Resorcinols:—Synthesis of Polyalkyl Resorcinols.

By R. C. SHAH and P. R. MEHTA.—A summary of the thesis submitted by Mr. P. R. Mehta in May 1935 for the M.Sc. degree of the Bombay University, from the Royal Institute of Science Bombay.

C-Alkyl phenols and particularly C-alkyl resorcinols have assumed great importance since the classical researches of Johnson and Lane (J. Amer. Chem. Soc., 1921, 43, 3487) and Dohme, Cox and Miller (ibid, 1926, 48, 1688), which culminated in the discovery of 4-n-hexyl resorcinol a valuable internal urinary anti-septic. In addition, C-alkyl resorcinol compounds have an interest of their own in organic chemistry, as some of them or their derivatives have been obtained by the degradation of important natural products.

A number of differently substituted C-alkyl monohydric phenols have been prepared by various workers to study their antiseptic action. Similar investigations have been carried out also in the resorcinol series.

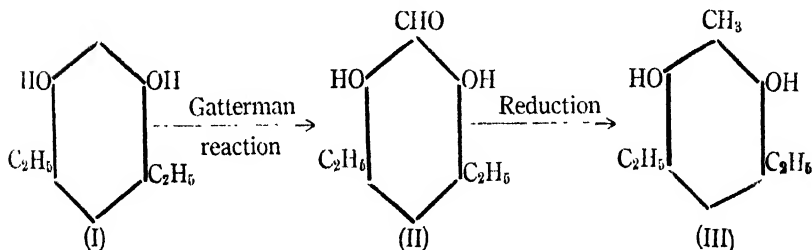
The influence of two alkyl groups in the resorcinol molecule on the antiseptic activity have been studied by Klarman (J. Amer. Chem. Soc., 1926, 48, 2358), who has synthesized 4:6-dialkyl resorcinols.

As no work appeared to have been done upon polyalkyl resorcinols containing more than two alkyl groups, the present work was undertaken, with the object of synthesising typical polyalkyl resorcinols containing more than two C-alkyl groups, which could thus be made available, for a study of the influence of more than two alkyl groups on the

(page 109).

An interesting observation has been made that 4:6-diethyl resorcinol (I) does not undergo the Höesch condensation with acetonitrile to give the 2-acetyl compound. However it readily undergoes the Gattermann reaction and yields the corresponding 2-formyl compound namely 2:6-dihydroxy-3:5-diethyl benzaldehyde (II), converted by reduction into 4:6-diethyl-2-methyl resorcinol (III).

The orthohydroxyaldehyde structure of the aldehyde has been confirmed. (1) Knoevenagel condensation with malonic ester afforded the 3-carboethoxy coumarin derivative; this Knoevenagel reaction appears to have been little used by the previous workers, as a characteristic reaction of orthohydroxyaldehydes. (2) Condensation with 5:6-dimethoxy



antiseptic activity and to study as far as possible, the properties, particularly chemical, of these highly alkylated resorcinols.

4:6-diethylresorcinol was synthesised and its various reactions were studied which are described in the original paper on 4:6-diethyl resorcinol in this volume

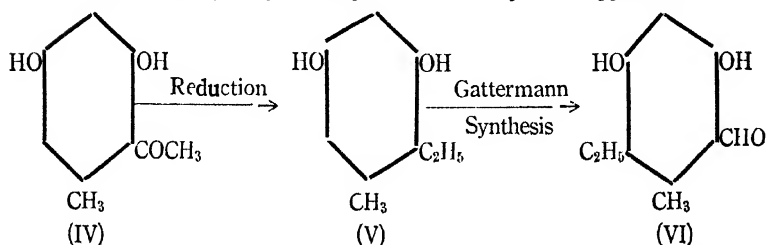
-1-hydrindone by the Perkin-Robinson method, gave a deeply coloured, well crystallised pyrylium salt. This aldehyde is of interest as it is a Y-resorcyaldehyde, only two of which type appear to be known.

Orsactophenone (IV) was reduced to 4 ethyl-5-methyl resor-

cinol (V) according to Robinson and Shah (J., 1934, 1498). This phenol was mercurated and also condensed with malic acid and aceto acetic ester and the corresponding coumarins were obtained. The Gattermann reaction gave 6-methyl-5-ethyl-2:4-dihydroxy benzaldehyde (VI)

The orthohydroxy aldehyde

edly, an interesting pyrylium salt (VII) which is probably formed from the expected 3-acetyl coumarin initially obtained, by further condensation with a second molecule of the orthohydroxy benzaldehyde. This pyrylium compound shows interesting properties and is of importance as such compounds appear to have

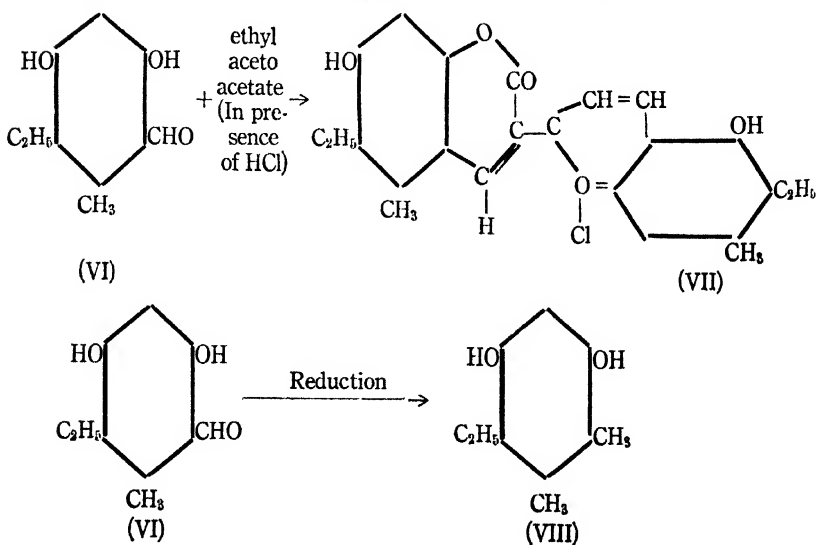


structure was proved as before.

(1) The aldehyde gave with 5:6-dimethoxy -1-hydrindone, the characteristic pyrylium salt: (2) The Knoevenagel condensation with malonic ester gave the expected 3-carboethoxy coumarin.

An analogous reaction with acetoacetic ester gave unexpected

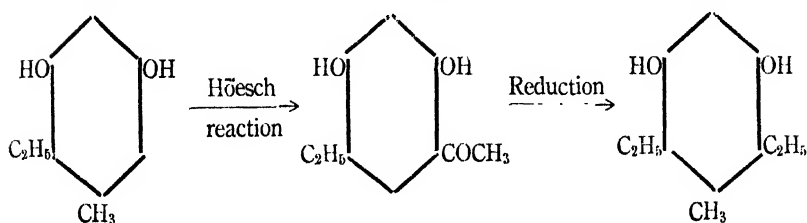
been very little studied, perhaps the only recorded observation being, by Le Févere (J., 1934, 450) who has obtained such a compound by condensation of salicylaldehyde and ethylacetoacetate in the presence of hydrogen chloride. Reduction of the aldehyde finally gave 4-ethyl 5:6 dimethyl resorcinol (VIII).



4-ethyl-5-methyl resorcinol (V) by the method of Hoesch, gave the ketone, 5-ethyl-6-methyl-2:4-dihydroxyacetophenone (IX). This when reduced by Clemmensen method gave 4:6-diethyl-5-methyl resorcinol (X).

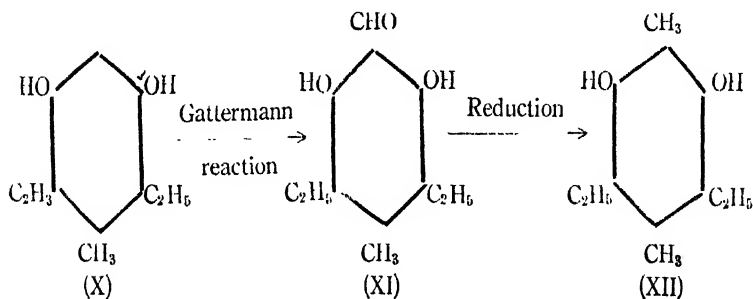
—dimethoxy-1-hydrindone by the Perkin—Robinson method.

Reduction of the aldehyde in the usual way afforded, 4:6-diethyl-2:5-dimethyl resorcinol, a tetra-alkyl resorcinol (XII). This compound is of unusual interest, as it is the first tetra-alkyl



The corresponding 5-hydroxy coumerin derivatives were prepared as usual by Pechmann reaction with malic acid and acetoacetic ester.

resorcinol to be synthesised. It is relatively very unstable and turns into a brown pasty mass spontaneously on standing.



4:6-diethyl-5-methyl resorcinol (X) underwent the Gattermann reaction, giving 3:5-diethyl-4-methyl-2:6-dihydroxybenzaldehyde (XI), a Y-resorcylaldehyde. As expected it gave a 3-carbethoxy derivative with malonic ester by the Knoevenagel method and a pyrylium salt by condensation with 5:6

AC

R. C. S.

10—*X-Ray Investigation of crystals of Benzoin and O-Nitrodi-phenylamine*. By MATAPRASAD and JAGDISH SHANKAR. A summary of the thesis submitted by Mr. Jagdish Shanker for the M.Sc. degree of the Bombay University (February 1935). Royal Institute of Science, Bombay.
 PART I—Benzoin.

The crystals belong to the monoclinic prismatic class and the crystals examined develop $\{100\}$ and $\{20\bar{1}\}$ faces.

Rotation photographs taken about the three axes, using copper radiations from a Shearer gas tube gave the following dimensions for the unit cell :—

$a = 19.81 \text{ \AA}$, $b = 5.434 \text{ \AA}$,
and $c = 10.55 \text{ \AA}$, $\beta = 106^\circ 50\frac{1}{2}'$
The axial ratio agrees very well with that given in Groth.

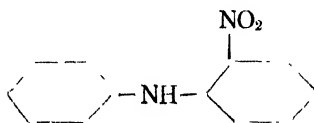
Oscillation photographs taken about the b and c axes show that (hol) planes are halved when h is odd and (010) is also halved. The crystals thus belong to the space group C_{2h}^2 . The calculated number of molecules and that required by the space group is four showing that the molecules are asymmetric. It appears, however, that the molecules are orientated in a manner similar to dibenzyl as found by Dhar and by Robertson by X-ray methods and by Krishnan from magnetic measurements.

PART II—O-Nitrodiphenylamine

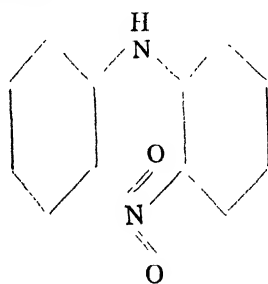
The crystals belong to the orthorhombic bipyramidal class. A direct measurement of the angles between (III) planes developed on the crystals shows that the axial ratio given in Groth is correct. The rotation photographs gave the following values for the length of the axes.

$a = 6.92 \text{ \AA}$, $b = 14.995 \text{ \AA}$
 $c = 10.32 \text{ \AA}$.

Oscillation photographs taken about a and b axes show that the crystals belong to the space group Q_{22}'' with Bravais lattice. The number of molecules calculated from the dimensions of the cell and density of the crystals is four while that required by the space group is eight. This indicates that there is some symmetry in the molecules. From the chemical formula



there seems to be no likelihood of a molecular symmetry. The possibility that the crystals may belong to some other crystal class has also been thoroughly investigated, and it is found that they do not belong to any other class. The following arrangement of the rings has consequently been suggested :



M. P.

X-Ray Investigation of the Crystals of m-Azotoluene and Dibenzyl By MATA PRASAD and H. H. DALAL. A Summary of the thesis submitted by

Mr. Dalal for the M. Sc. degree of the Bombay University (August 1934), Royal Institute of Science, Bombay.

Part 1—m-Azotoluene

Crystals of m-azotoluene belong to the rhombic bipyramidal class. They were examined by rotation and oscillation method using X-rays from a copper anticathode and a Shearer gas tube. The dimensions of the unit cell were found to be $a=11.8 \text{ \AA}$, $b=13.75 \text{ \AA}$, $c=7.52 \text{ \AA}$. From the reflecting planes (hol) were found to be halved when h is odd and (hko) halved when k is odd. This shows that the crystals belong to the space group Q''_h . The number of molecules in the unit cell is calculated to be four which is half the number required by the space group, indicating some molecular symmetry. Various possibilities of the arrangements of the molecules in the cell have been considered.

Part II—Dibenzyl

These crystals belong to the monoclinic prismatic class. A similar study as in Part I, gave the following dimensions for the unit cell :—

$$a = 12.7 \text{ \AA}, b = 6.11 \text{ \AA}, c = 7.61 \text{ \AA}, \beta = 114^\circ 48'$$

In this case (hol) planes are halved when h is odd, and (010) is also halved. These halvings correspond to the space group C_{2h}^2 . The number of molecules

in the unit cell is two, while the space group requires four molecules per unit cell. This shows that the molecules have a centre of symmetry. These results agree with those obtained by Krishnan by the magnetic methods.

M. P.

Active Principles from The Fruits of Solanum Xanthocarpum. By I. Z. SAIYED and D. D. KANGA (A summary of the thesis submitted by Mr. I. Z. Saiyed for the M. Sc. degree of the Bombay University, (May 1935). M. R. S. Institute, Gujarat College, Ahmedabad and Royal Institute of Science, Bombay.

Solanum Xanthocarpum known as Bhoringani in Gujarati, Bhutkatya or Bhumiringani in Hindi, Kanteringani in Marathi, etc. is well-known in Hindu Medicine as its roots are one of the constituents of 'Dashmul Ashava.' This plant grows abundantly in India in wild state, particularly in Deccan round about the Malabar coast and in Punjab. The stems are greenish grey in colour, round in shape, and with innumerable spines. The flowers are bright blue in colour. The berries are spherical of the size of a large gooseberry, very smooth, and drooping; when immature they are green, interspersed with white bands, but when they are ripe they are of different shades of yellow only.

In Hindu Medicine the plant is described as aperient, pungent, bitter, digestive, alterative and astringent; useful in fever, cough, asthma, costiveness, and heart diseases. The stems, flowers and fruits, according to Dr. Wilson (Calcutta Med. Phys. Trans. Vol. II, pp.406) are bitter and carminative, and are prescribed in those forms of ignipetiditis which are attended with a vesicular and watery eruption. Fumigation with the vapour of the burning seeds of the plant is in high repute in the cure of tooth-ache. In the Konkan two tolas of the juice of the fresh plant with two tolas of Hemidesmus juice are given in whey as a diuretic, and the root with the chiretta and ginger is given in decoction as a febrifuge. The root beaten up and mixed with wine is given to check vomiting. The juice of the berries is useful in sore throat. In the Punjab Hills the juice of the plant is administered with black pepper in rheumatism. A decoction of the plant is used in gonorrhoea. It is also thought to promote conception in the female. Fine powder of the fruits of this plant with honey is used for chronic coughs in children (A Treatise on Vegetable Materia Medica, Part II, by Vaidya Bapalal G. Shah).

The plant under investigation belongs to the natural order Solanaceae. Of the two classes of the alkaloids which have been isolated from some of the plants belonging to this order, one class

gives alkaloids uncombined with sugars, such as the three best known alkaloids, atropine, hyoscyamine, and hyoscyne, while the other class gives alkaloids combined with sugars and are known as gluco-alkaloids.

A study of the literature on the subject of gluco-alkaloids shows that the composition of not a single solanine or its hydrolysed product, with the solitary exception of *Solanum Augustifolium* (Tutin and Clewer, J. C. S. 1914. T, 559) has been definitely established.

Dymock (Pharmacographia Indica, II, pp. 559) states that the fruits of *Solanum Xanthocarpum* were found on analysis to give alkaloidal reactions corresponding to solanine. The dried leaves gave 29.7 % ash and contained a trace of an alkaloid and an astringent organic acid giving green precipitate with ferric chloride.

G. Pendse and S. Pendse Indian J. Med. Research, 20, 663-70, 1932) describe an alkaloid in the plant (plant complete with berries) which they say is present in very small quantities. They attribute the physiological activity of the whole plant to potassium nitrate which is present in it to the extent of 1.6 %.

The present authors undertook the investigation of the fruits of *Solanum Xanthocarpum* with a view to isolate the active principle or principles from the drug, to determine their composition and

then to have their pharmacological action investigated. Three crystalline compounds have been isolated and their composition determined. They are, a gluco-alkaloid, an alkaloid and a sterol. The gluco-alkaloid which has been given the formula $C_{44}H_{78}O_{19}N$ or $C_{44}H_{76}O_{19}N$ is termed 'Solancarpine'. The alkaloid which has been given the formula $C_{26}H_{44}O_3N$ is termed 'Solancarpidine'. The sterol which has been given the formula $C_{36}H_{54}O_4$ is termed 'Carpesterol'. The products of hydrolysis of the gluco-alkaloid have been found to be the alkaloid (shown above) and glucose, rhamnose and a hexose probably galactose. There is also obtained an inorganic mineral salt which was identified as potassium chloride.

EXPERIMENTAL

The fruits of the drug under investigation were locally purchased and coarse powder prepared from them. Small portions of this material were then subjected to some preliminary tests when indications were obtained of the presence of an alkaloid, reducing sugar and an inorganic salt, potassium chloride.

For the purpose of complete examination 40 lbs. of the material were successively extracted with petroleum ether and alcohol in a large copper soxhlet.

PETROLEUM ETHER EXTRACT

After the removal of the greater

portion of the solvent, the extract yielded a solid crystalline substance, and on further evaporation, an oil. The solid substance was crystallised from boiling alcohol, when it gave the melting point $248^{\circ}C$. On analysis it gave the following result :—

C, 78.86 and H, 9.4. $C_{36}H_{54}O_4$ requires C, 78.54 and H, 9.81.

This substance showed colour reactions characteristic of phyto-sterols and formed an acetyl derivative, which gave the following result on combustion :—

C, 77.09 and H, 10.13, $C_{36}H_{56}O_5$ requires C, 77.03 and H, 9.5.

This result showed the presence of one $--OH$ group. Hence the substance has been designated 'Carpesterol' with reference to the source from which it has been isolated.

ALCOHOLIC EXTRACT

After removing the solvent by distillation, the extract was dried and treated as under :—

It was first treated with water, which dissolved the greater portion of the extract. The insoluble portion was then treated with dilute acid. It also dissolved some of the extract (acid solution). The extract which was insoluble in both of the above mentioned solvents was dissolved by dilute alkali (alkaline solution).

(1) *Aqueous Solution* : This solution was clarified with neutral lead acetate etc. and the basic

portion was precipitated with dilute ammonia. This precipitated solid was purified and crystallised from alcohol. It gave the m. p. $288-89^{\circ}$ C (decomp.). On combustion it gave the following result :—

C, 56.93 and H, 8.492 and N, 1.51. $C_{44}H_{73}O_{19}N$ requires C, 57.14, H, 8.54 and N, 1.51 or $C_{44}H_{76}O_{19}N$ requires C, 57.26, H, 8.24 and N, 1.51.

This substance was hydrolysed with dilute sulphuric acid. On hydrolysis it gave a solid and solution. The solid was decomposed with dilute ammonia and extracted with ether. The ether extract yielded a crystalline substance, which on recrystallisation from alcohol gave the m. p. $197^{\circ}-198^{\circ}$ C. Its analysis gave the following result :—

C, 74.59 and H, 10.39 and N, 3.37. $C_{26}H_{44}O_8N$ requires C, 74.64, H, 10.52 and N, 3.34.

The solution hydrolysis product contained sugars, which were identified by the formation of their mixed osazone and examining this osazone by Perkin's method (J. C. S. T, 1920, 97, 1777) and the solubility of rhamnosazone in acetone and the insolubility of glucosazone in acetone, when the mixed osazone was treated with this solvent. These experiments showed the presence of glucose, rhamnose and another hexose probably galactose.

The two substances mentioned above viz. the unhydrolysed and the hydrolysed gave colour tests characteristic of alkaloids with all the common alkaloidal reagents and concentrated sulphuric acid. These two substances have been designated 'Solancarpine' and 'Solancarpidine' respectively, with reference to the source from which they have been isolated.

(2) *Acid Solution*: This acid solution of the alcoholic extract was precipitated with dilute ammonia. Since this solid gave tests for an alkaloid but could not be crystallised, a salt of the substance was formed, which was then decomposed and extracted with ether. The ether extract yielded a crystalline substance, which was found to be identical with the substance m. p. $197^{\circ}-98^{\circ}$ C obtained from the gluco-alkaloid on hydrolysis.

(3) *Alkaline Solution*: The alkaline solution of the alcoholic extract was not examined further as the quantity was very small.

The following derivatives of the base 'Solancarpidine' were prepared :—

(1) Hydrochloride, (2) Hydrobromide, (3) Hydriodide, (4) Sulphate, (5) Nitrate, (6) Acid Oxalate, (7) Acid Tartarate, (8) Picrate, (9) Bichromate, (10) Acetate, and (11) Chloroplatinate.

D. D. K.

Notes and News

I

The news of the earthquake at Quetta descended like a thunderbolt on a fine morning of the 1st of June and spread like lightning throughout the four corners of the world. The blow was both terrific and sudden ; the loss in life and property most appalling. The victims of the Quake who numbered thousands, when they went to sleep full of life and hope on the night of the 31st May, could not have dreamed that they would fall into everlasting sleep on the following morning, and what was the condition of those who escaped death ? Most of them have lost their nearest and dearest ones, some, one, some two and some their whole families ; and as if this calamity was not enough, many have lost their limbs and all their possessions in addition. The Quake did not make choice amongst its victims ; it claimed all, old and young, rich and poor, high and low, strong and weak, men and women of different races and faiths and castes and creeds. The whole civilised world was electrified when the news of the dire calamity at Quetta reached them on the morning of the 1st of June. It stirred their hearts and their imagination to an extent as no other recent event in history has done. Common calamity makes people forget their differences ; "human nature rises to its full stature only in the face of dire calamity" ; it makes people realise that the world is after all one people, that they all constitute one humanity, whatever the external labels may be. The relief for the suffering humanity at Quetta came from distant places ; it was generous and spontaneous. The appeal for help was world-wide, the response too had been world-wide, proving that the unity of mankind and brotherhood of humanity were not mere words but facts in nature. How long would this feeling of brotherhood last ? Could it not be made continuous, a more permanent thing ?

Was it because the world was found to be drifting this year more than in the preceding years from the path of peace and goodwill, sanity and wisdom that this calamity came as a reminder to the nations of the world that the policy which they were following was not one which was conducive to the promotion of peace and happiness but one which would lead to strife and discord.

We had dilated at some length in our previous Notes and News on the big gap which existed between the rapid scientific advance on the one hand and the stationary ethical position on the other—a gap

which threatened the disruption of civilisation. We had suggested then a fuller and completer development of human nature, an all-round development of the human personality, by the study of courses which would emphasise not only one aspect of human nature viz. intellectual, but also the others which are neglected at present viz. emotional and spiritual and in the introduction of which the Universities should not lag behind. A lop-sided development of human nature, either intellectual or emotional cannot take a most comprehensive view of the world situation.

Everyone who studies the world events is painfully conscious of the fact that the peace which the League of Nations is trying to establish in the world is receding further and further for the simple reason that the principal members of the League act on principles which are fundamentally opposed to those of the League. They go on increasing their aeroplanes and submarines, tanks and dreadnaughts and strengthening their land, water and air forces ; they do so because of mutual suspicions, jealousies ; no nation trusts another nation.

It would be absurd to expect an individual who has not attained peace by harmonising his thoughts, feelings and actions, in whom there is conflict, discord and disharmony, to talk of peace ; it would be folly to expect such a person to spread ideas of peace and goodwill. Equally absurd and foolish it would be to expect one nation or the League of Nations to establish peace in the world as long as they are guided by persons, who have not attained the inner peace and harmony which are characteristics of men who have gained a mastery over their lower desires and thoughts, who have brought about an alignment between their thinkings and doings and who always think and speak and act in terms of humanity, who are self-effacing, who always think of sharing their best with others, who use the power they wield, not only for the advancement of their own country but also for the advancement of other countries and who, while thinking of the interests of their own countrymen, also think of the interests of the people of other countries.

It is true the knotty economic and political problems facing the world to-day are not easy of solution ; difficult and complex they are but not impossible of solution. The best intellects of the world inspired with the highest motives must be brought to bear on them if they are to be solved at all. While we have offered some adverse criticisms against the League of Nations we cannot help mentioning that if there is at present any international body in the world which has for its aim the establishment of peaceful and harmonious relations between nation and nation and which is to act as an arbiter when there is a difference of opinion, it is the League of Nations, but if the work of

the League is to be made effective it must have the *power* to enforce its will and decisions and that its work should be above the slightest shadow of suspicion.

What part could the Universities of the world take in the solution of these problems? These problems would never be solved as long as every boy and girl is taught at home and at school that the interests of his or her country are above those of any other country in the world. The problems will be nearer solution only when every boy and girl is taught that he and she are members of one world-nation and one human family. To bring about this desirable change in the outlook of the youths every University should see that any system of education which inculcates narrow notions of nationality is completely overhauled and secondly it should see that every alumnus receiving education under its portals receives such education that it brings about an all-round development of his nature.

The world is governed by ideas and if we wish to bring about this much-to-be-desired orientation in the world's thought then we should see that we give every possible support to the League of Nations and strengthen the world opinion in its favour and also of other bodies, and there are several, which have for their aim the establishment of peace and that every boy and girl grows up in the atmosphere of this changed mental outlook.

II

A great cataclysm like the one which the unfortunate people at Quetta recently went through naturally awakens in our mind a good many thoughts. The first and foremost is the thought that science was not able to predict the occurrence of such a sudden overwhelming catastrophe as that of the earthquake which we recently had at Quetta. The scientists have to make an honest and humble confession of their inability to predict and consequently warn the people in time of the impending danger. Had it been possible to do so, there would not have been such a heavy loss of precious life. Mighty reactions and changes on a gigantic scale must be taking place in the bowels of the earth some time before the actual occurrence of such cataclysms. Is it not possible to devise sensitive instruments which would give an indication of these changes? There is ample room for research in this direction.

The second thought which presses itself upon us is whether there is any design in the occurrence of such cataclysms. The book entitled "The Great Design: Order and Intelligence in Nature" edited by Frances Mason with a valuable introduction by Sir J. Arthur Thomson published in 1934, answers this question in the affirmative. The study

of the book, which contains a collection of monographs by fourteen men of international reputation, each an expert in his own branch of science, reveals an important point that evolution is not, as was hitherto supposed, 'the result of a fortuitous concourse of atoms' but that there is ordered harmony, mathematical precision and a great design and consequently a Purposive and Directing mind behind the great drama of creation. If that is the case, then the recent convulsion and cataclysm as well as many others which the Earth has experienced in its long past history were 'part of Nature's mechanism for readjusting the earth's surface to the requirements of racial evolution.' Is there a connection between the occurrence of earthquakes and the appearance or birth of new races? Mighty upheavals have taken place in the past; titanic forces which are at work in the womb of the earth have several times brought about a redistribution of land and water on the surface of the earth, a change of climates etc. Continents have been submerged and waters of the ocean are now rolling over them. New continents have emerged where formerly there were seas and oceans. Are the islands in mid-oceans tops of the highest mountains which once raised their proud heads on the continents now submerged as revealed by the nature of vegetation formed on them? How far is the supposition true that the old earth becomes exhausted by the multitude of men and animals fed upon it and so needs renovation so that it may become virgin once again and become a befitting abode for a new race, a new and suitable home for a new civilisation? These are some of the questions which naturally arise in one's mind on the occurrence of a great cataclysm like the one we had at Quetta and which it would be worthwhile our scientists,—particularly our meteorologists and ethnologists, palæontologists, geologists and biologists—to think over and ponder, investigate and solve.

D. D. K.

III

We had referred in one of our past issues (P. 363, Vol. II, Part II) to the necessity of procuring pure wholesome food for the maintenance of the health of the people. The large number of prosecutions by the Health Department, Bombay Municipality show to what a great extent ghee and butter are adulterated. The result of these prosecutions was not as satisfactory as was expected, for the simple reason that the miscreants were let off with easy fines. The punishment was not commensurate with the gravity of the offence. We would suggest that all cases of tampering with the purity and wholesomeness of food by adulteration should be sent for trial to one of the following officers, who realising the gravity of the offence, would give exemplary punishment to the offenders,

namely, the Principal of the Royal Institute of Science, the Deans of the two Medical Colleges, the Deans of the Faculties of Science and Medicine. It should be noted in this connection that the manufacturers of adulterated ghee, butter, other foodstuffs and medicines should be considered as greater offenders than the sellers; they should be found out and hauled up before the Magistrate. It is only in this way that the Health Department may be enabled to bring this mal-practice under control and eradicate it in the near future.

D. D. K.

Reviews

THE TWENTY-SIXTH ANNUAL REPORT—THE INDIAN INSTITUTE OF SCIENCE, 1934-35

We have received a copy of the twenty-sixth annual report of the Council of the Indian Institute of Science for the Session 1934-35 which makes a very interesting and instructive reading. The Director and Staff deserve to be congratulated on the fine results obtained as shown by the large number of original publications from the different departments during the year under report. The newly-opened Physics Department, in spite of many difficulties, had 39 original papers to its credit; the Department of Chemistry (General and Organic) 23 between its two divisions; the department of Biochemistry 49 and the department of Electrical Technology 15, making a total of 126 papers which is undoubtedly a fine achievement.

The total income for the year under report was Rs. 5,45,624. The expenditure for the same period was Rs. 6,57,941, showing an excess of Rs. 1,12,317 over the income. The total number of students during the year under report was 181 of which the Department of Electrical Technology claimed 50 per cent. and the departments of Chemistry, Biochemistry and Physics 22, 16, and 11 per cent. respectively. The expenditure per student thus comes to Rs. 3635 per year. This may seem to be a big figure to a layman and naturally lead him to inquire as to whether the Institute has achieved any substantial results during its existence of 26 years commensurate with the sum it spends per each student per year and whether it has been able to implement its declared policy and justify the hope of its large-hearted and far-sighted donor, the late Mr. Jamshedji Nusserwanji Tata and to find out how far the researches carried out in the Institute during the last quarter of a century have gone to help, directly or indirectly, industry, or science (pure and applied), or both. A report of the Institute of the last 25 years treated from this point of view and including a comparative statement of expenditure per student per year of other Research Institutions of a similar kind in other parts of the world would be helpful and illuminating.

The excess of expenditure over income by Rs. 1,12,317 during the year under report does not show a sound financial position of the Institute; in this connection the recommendations of the Economic

Committee appointed by the Council will go a long way to stabilise the financial position of the Institute and we are glad to find a saving of Rs. 20,000 in recurring expenditure in the budget of 1935-36 as compared with the budget for 1934-35. The other recommendations of the Economic Committee were "the promotion of the newly opened Department of Physics, the foundation of a Chair of Mathematical Physics and the development of the Central Workshop as a centre of Mechanical Engineering and industrial Research." We are of opinion that if the name "central Workshop" be expanded to "central Workshop and Department of Applied Chemistry" and if it is made to include "Chemical Engineering" as well, it would catch the imagination of the commercial people and industrial magnets and induce them to give large sums of money ear-marked for some specific industrial research.

This review would not be complete without reference to a significant event which occurred during the year, namely, the foundation of the Indian Academy of Sciences which will play an increasingly important part in the advancement of Science in India. It has begun well, shows great vigour and is filling an important gap in the scientific life of the country under the able presidentship of Sir C. V. Raman who is also the Director of the Institute.

D. D. K.

REPORT OF THE ROYAL INSTITUTE OF SCIENCE, 1926-34

The copy of the Second Report of the Royal Institute of Science, Bombay for the period 1926-34 which we have received for review affords an interesting reading. It shows an all round progress in all the departments of the Institute and the Principal and members of the teaching staff deserve to be congratulated on their fine achievements. Taking into consideration the number of the undergraduate and post-graduate students in the year 1933-34 and the accommodation available it seems the Institute has been working to its maximum capacity and if the same rate of increase in the number of post-graduates continues the Principal will be faced with the difficult question of finding out further accommodation for the increasing number of post-graduates seeking admission to the Institute. Government will have to tackle this problem sooner or later, sooner rather than later and will have seriously to consider the question of relieving the Royal Institute of Science of a major part of its undergraduate teaching, namely F. Y. A. Physics and I. Sc. courses, if not the whole of it, to begin with.

The contract grant fixed for the year 1934-35 was Rs. 32,500, the average of the last three years being Rs. 32,830. The expenditure per student per year in the year 1932-33 was Rs. 608. The total number of papers published during the period under review (1926-1934, 1st quarter) was 128 and the total number of approved M. Sc. theses for the same period came to 96; the total number of researches in progress in 1933-34 was 101. Thus the report shows that a considerable progress has been made during the period under review to develop the Institute into a centre of post-graduate work and research in science. To make further progress in the same direction it will be necessary, as the Report observes, (1) gradually to discontinue the undergraduate teaching which takes up at present 50 per cent. of the space of the Institute, (2) to create a number of bursaries so that the holder may become self-supporting and work after taking the M. Sc. degree for the Ph. D. and D. Sc. degrees of the Bombay University. Research of the high quality can be carried out only with the aid of such trained students; (3) to increase the staff, the equipment, and the grants of the Institute. It would be desirable to have a graded staff with an assistant Professor and a Lecturer added to the existing cadre in each department; (4) to promote in every possible manner the prosecution of original research work of a high order by the staff and students. To carry out these objects what is required is money.

Scientific research is the life blood of every industry; the prosperity of an industry depends upon the development of scientific research and encouragement and financial help given to it. This link between science and research on one hand and industry on the other requires to be forged. In other words the public in general and the industrialists in particular require to be *educated* by lectures illustrated with slides and cinema films, by opening museums, by practical demonstrations and by showing them what the other countries are doing in this direction. The Royal Institute of Science with its highly qualified staff is the best body to forge this link. The newly opened Department of Chemical Technology may join hands with the Royal Institute of Science in this matter and both together may carry on vigorous propaganda in the two chief industrial centres of the Presidency, namely, Bombay and Ahmedabad and convince the industrialists that they stand to gain by any help which they might give for research in the form of donations, scholarships etc. We would earnestly appeal both to Government and industrialists to give generously if they wish to see the Royal Institute of Science take its rightful place in the life, industry and culture of the Presidency.

D. D. K.

Junior Trigonometry for Colleges, By MESSRS. K. S. PATRACHARI, M. A., L. T. and S. A. MANI, M. A., L. T. (Longmans, Green & Co., Ltd. Price Rs. 2/-)

It would not be fair to look for originality in a college text-book, especially in a subject like Trigonometry where so many text-books have appeared that not only the book-work but the examples too have become standardised. We may, however, expect a thorough presentation in any mathematical book coming from Kumbakonam, the fountain head of Indian Mathematics and we find it in the *Junior Trigonometry for colleges* by Professors Patrachari and Mani of the Government College, Kumbakonam. The book is handy, well printed and illustrated with neat figures and may be recommended as a text for the Intermediate stage. It also contains a number of solved examples, to illustrate methods of solution, but one wonders if a solution like that of ex. 17 on p. 18 is really helpful to the student. Thus in solving the equation $2 \cos^3 \theta + \sin^2 \theta = \cos \theta$ one would naturally proceed to change $\sin^2 \theta$ into $1 - \cos^2 \theta$ thus giving a cubic equation in $\cos \theta$; instead of which, the terms in $\cos \theta$ are first collected together and factorised, and as the factor $1 - \cos^2 \theta$ happens to be conveniently present, that is changed into $\sin^2 \theta$. So the solution appears to depend more on good luck than on any systematic attempt on the part of the student.

We may also question the remark on p. 29 viz. "When we say that $\sin \theta^0 = 0$, we do not mean that the sine of a zero angle is zero. Such a statement would be absurd, because a zero angle will mean an angle which is non-existent, and when there is no angle, how can we speak of its sine? The statement is used to indicate the fact that, if an angle becomes very small, its sine also becomes very small, or more precisely, the sine of an angle can be made to differ from zero by as small a quantity as we please, by taking a sufficiently small angle."

Has a zero angle then no business to exist in its own right, but only as a limiting case?

However these are minor blemishes which do not detract from the merits of this useful book.

Relativity By F. W. LANCHESTER LL. D., F. R. S. (Constable & Co. Ltd. pp. xii & 222; price 12/-).

We have here an interesting little volume by the famous auto and aero engineer, Dr. Lanciester, proposing to give "an elementary explanation of the space-time relations as established by Minkowski and a discussion of gravitational theory based thereon."

In part I which consists of 5 chapters, a discussion of the special theory of relativity is given. The author shows great respect to Minkowski's synthesis of space-time but curiously enough is suspicious of Einstein's philosophy on which it is based. He gives an elementary derivation of the Lorentz transformation from the postulate of the constancy of the velocity of light for all observers but doubts if the velocity of light is actually the boundary velocity. Again by defining the *cosmic velocity* of a particle to be $\log \frac{(c + v)}{(c - v)} \frac{1}{2}$, he obtains the

Newtonian law for the addition of *cosmic* velocities and regards the mass of a particle as independent of its velocity ; and so on.

Part II is wholly original. The author is not satisfied with Einstein's general theory of relativity and modifies the classical theory of gravitation by supposing the orbits of the planets to be subject to the Fitzgerald contractions appropriate to their velocities. The amount of "deficiency" for circular orbits thus comes out to be about 3 miles for every planet of the solar system. It moreover explains the bending of light in the Sun's gravitational field as given by Einstein's theory. But the author is modest enough to state that he is not satisfied with even his own theory, which "lacks finality" and in which "there is a certain want of cohesion." In the concluding chapters the author similarly criticises the conceptions of spherical or other types of universe, arising from "the equations of the mathematicians or rather from the faulty interpretation put upon them." He does not think, however, "that we have any business to concern ourselves with theories relating to the ultimate, it savours too much of the theologian ; but in accordance with the true spirit of scientific philosophy, we should endeavour to unravel the skein from the end we hold in our hands, rather than make premature guesses or assumptions concerning the remote origin of the tangle."

There are 12 appendices, some dealing with mathematical points left out from the body of the book and other discussing relevant topics at greater length.

The book is very interesting but is not meant for a beginner who wishes to make a study of Einstein's theory. The elementary discussion moreover suffers from too much condensation. Thus the aim of §19 as stated on p. 24 does not appear quite clear ; nor is it stated anywhere that fig. 4 is an elevation and not a diagram of the usual type. Similarly in §24, figures 11 and 12, to derive the Fitzgerald contraction the rod in the K system will not appear parallel to A, B, as may be deduced by the beginner. Its representation in space-time to K is the oblique trace between the parallel lines as shown, but its position at any instant (K's) is parallel to AB. When measuring it therefore

there is no reason why K should allow it to slide along his own measuring rod as suggested in 28. These and other points require to be made clear.

The book is well printed and illustrated. Some diagrams are repeated to facilitate reference without turning over a page: a useful innovation. But the price 12/- appears to be a bit too stiff.

K. R. G.

Elementary Electricity and Magnetism. By R. W. HUTCHINSON, M Sc., (University Tutorial Press) London, 1934, 6/6.

The first and the foremost aim of the writer of this book, as he puts it, has been to produce a modern elementary book suitable for junior readers—an elementary book in accordance with the science as we know it *to-day*, not as it stood thirty or more years ago. This aim has been successfully achieved. The book is made as representative of modern ideas as possible. It would be an excellent book for the I. Sc. students of this University. The experiments are chosen carefully. The demonstration of the Ampère's rule (P. 105) and the dependance of the potential on the surface of the conductor (p. 186) are really interesting and simple. The diagrams of apparatus are also plainly drawn, avoiding most of the unnecessary details. The telephone circuit (p. 405) is an excellent illustration. The book has that touch of completeness inasmuch as it finds room for accounts of the Television and the more recently known Neutrons, Dipsons and Positrons.

G. R. P.

Sound. A physical text book. By E. C. RICHARDSON, B.A., Ph.D., D.Sc. (Edward Arnold and Co., London, 1935) 2nd. Ed. 15/-.

The importance of the study of sound has increased of late. Greater attention is being paid to the subject by students and research workers in the last twenty years or so particularly on account of the extraordinary development of broadcasting and the rapid progress in the recording and reproducing apparatus employed in the talkies. It has proved once more that any particular branch of science, however academic it may look in the beginning, suddenly rises into practical eminence when it finds application in industry. Sound is one such subject. It occupies quite a different position in physics to-day than it ever did before.

AE

The book has an ambitious programme. It covers all that a student requires for a degree examination of the university, but it contains something more. It contains information which would meet the needs of the research worker and the technician by describing the important work in applied acoustics and by giving copious references to original papers.

The chapter on acoustic impedance deals with the design of acoustic filters. The information should prove useful and inspiring for anyone who is anxious to purify a note. The same could also be employed commercially, for instance, a low-pass filter in the tone-arm of a gramophone should be useful in filtering out the scratch of the needle. The same subject finds application in the designs of exhaust silencers of motor vehicles.

Much attention is devoted in this book to the recent work on supersonics. The chapters on subjective sound and technology of sound are most interesting and the reader would find enough evidence therein to convince him that sound of the present day is a subject of commercial importance.

G. R. P.

Heat. By R. W. HUTCHINSON M.Sc., (University Tutorial Press)
London, 1935, 3/6

This book deals with the elements of heat both theoretical and practical and is of a standard somewhat higher than the I. Sc. standard of this university. The subject matter is properly illustrated with numerous examples and applications from practical life.

G. R. P.

Elementary Mechanics and Hydrostatics. By F. BARRACLOUGH M. A.,
(University Tutorial Press) London. 1934, 3/6

This book is a clever attempt at writing on a mathematical topic in an interesting manner. The author holds a definite view that, whilst theory should not be neglected experiments must be performed if the subject is to be properly taught. Subjects such as these cannot be adequately dealt with in the mathematical class-room. The teacher may be a mathematician or a physicist, but his work of teaching can only be completed in a physical laboratory. The book is studded with numerous practical appliances and convincing experiments. Illustrations and examples are very carefully chosen. On page 80 there is a simple and appealing problem in graphical statics.

The Archimedes principle is explained by means of the experiment on page 121. The book can be usefully read by I. Sc. and J. B. Sc. students of this University.

G. R. P.

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PART III

THE QUEST AFTER BEAUTY IN CONTEMPORARY POETRY

I. Introduction :—The orientation of Contemporary Poetry is not towards Beauty, and yet a secret urge towards it is discernible.

II. The 'Quest' in Realistic Poetry :—A Renaissance of Wonder in regard to (a) Everyday Things : Rupert Brooke, J. C. Squire, Harold Monro, Edmund Blunden. (b) The English Country-side : Edmund Blunden, Edward Thomas, (c) Strange Landscapes : John Freeman, J. C. Squire, W. H. Davies.

III. Realistic Poetry :—Beauty and Terror : W. W. Gibson.

IV. The Poetry of Escape :—(a) Spiritual Nostalgia : Alfred Noyes. (b) The Mystics of Beauty : John Freeman, Squire, Walter de la Mare.

V. An Irish Mystic : James H. Cousins.

VI. The speculations and fancies of John Masefield.

VII. A Modern Eirenicon of Science, Philosophy and Religion : *The Testament of Beauty*.

VIII. Conclusion.

I.

(a) If for once we may permit ourselves to anticipate the judgement of Princess Posterity on the Perseus of contemporary song, we must say that the quality in him that will compel her admiration most is his readiness to wrestle with the Gorgon of experience,—his resolve not to remain content with mirroring her in a magic shield of idealism but to present an undaunted front to her petrifying gaze. A modern poet, like Masefield or Gibson, aims at making the reader a sharer in his own experience of life with its white heat of passion, struggle and tragedy—life as it is lived near the furnace, before the mast, or in the hovel. He considers it a false æstheticism to shrink from the stark facts of life, merely because they embrace squalor and

* In this article 'Modern' is synonymous with 'Contemporary.'

grime or induce in us a creepy horror and loathing against man's monstrous cruelty and the "faceless phantoms of Baal and Moloch."¹ The Georgian singer (with marked exceptions) flings away the trammels of large, universal, or general ideas and surrenders himself to the mood of the moment, without considering whether the mood he wants to capture and fix is one of soul-healing vision, or mere rise of temperature. There is substantial truth in the view that Georgian poetry is largely a poetry of moods and fleeting experiences, and in what Edmund Gosse wrote of it thirteen years ago:² "If we take the contents of this volume as typical of what is best in the poetry of the present day we may regard the Georgians as jewellers, while the Victorians were sculptors. The broad outline, the radiating vistas of intellectual and moral life do not interest these young poets in the least. Their eyes are not lifted to the mountains, but are occupied in the minute inspection of the ground. They listen to the whisper of their own inner feelings, and the daisy at their feet doth the same tale repeat. The result is that they lack in some degree the sense of proportion. They know not what to withhold, and they sow with the whole sack. No generation of writers, I suppose, was ever more obsessed with the charm of nervous sensibility, cultivated for its own sake, and not shrinking even from an apparently prosaic diction in order to emphasize its penetration." This love of minutiae, that discards selection and proportion and sows with a sack, is but the defect of a quality that imparts a hard-bitten strength to contemporary poetry. It has been rightly said that "one of the principal aims of the new poets is to increase consciousness." The purpose of art and literature is "to give us increased vitality and a more passionate sense of life and power of living...The modernist artist gives us the great chance of exerting an individuality in seeing. The older beauty, the beauty of the Old Masters, is the beauty of species and of mass—the new beauty is highly individualized and separate. The modern artist is not concerned with things in the mass, he is passionately interested in the fulfilling of the destinies of the single individuals that make up the mass—whether these individuals are men, or leaves or waves of the sea."³

Whatever may be the conscious aims of poets who consider themselves the inaugurators of a new age, they are, if the last secret is not altogether denied them, bound to be impelled by an urge

1 Consider J. C. Squire's *The Stockyard* or Francis Brett-Young's *The Quail*.

2 In his review of *Georgian Poetry*, Vol. V. (1920-22)

—Edited by Edward Marsh.

3 Edith Sitwell on *Experiment in Poetry in Tradition and Experiment in Present Day Literature*, pp. 82-83.

towards Beauty—an urge not the less imperious because unconscious. The Beauty that is an inner dynamic in the mind of the poet and yet lures him on and shimmers through all his writings springs from sources deeper than what any cult¹ may set up and strive towards as an ideal. The Beauty of which the artist is in quest, said Reynolds, is “an idea that subsists only in the mind; the sight has never beheld it, nor has the hand expressed it: it is an idea residing in the breast of the artist, which he is always labouring to impart, and which he dies at last without imparting.”² Coleridge describes in ecstatic language this “Beautiful and Beauty-making Power” in the Soul of the poet:

“Ah! from the soul itself must issue forth
A light, a glory, a fair luminous cloud
Enveloping the earth—
And from the soul itself must there be sent
A sweet and potent voice of its own birth,
Of all sweet sounds the life and element.
And thence flows all that charms of ear or sight,
All melodies an echo of that voice,
All colours a suffusion from that light.”³

But, as we have seen, this is not the major light that glows in the minds of Georgian poets, for, speaking in the rough, they are mainly concerned to study the *nugae* and the sensations that make up the sum of common life, to communicate to us their personal impressions of them, uncoloured by philosophy and the larger significance of things. Cornered and overshadowed, the inner yearning after Beauty asserts itself nevertheless in ways often new, often with a shy indirectness, and sometimes as a frankly rebellious, glorious passion. Our poets find the instinct of Beauty too imperious to be put by: they must come to terms with it somehow. To the student of contemporary poetry, the diverse forms in which this covenant with Beauty—or compromise with it—expresses itself is of great interest.

II.

(a) Several modern poets seek to strip off the pall of familiarity that lies heavy on the face of everyday things—the things that minister unobtrusively to our comfort or silently enrich our life, but are never allowed to challenge a place in our conscious life. Rupert Brooke's *The Great Lover* is a well-worn illustration:

“Then, the cool kindness of sheet, that soon
Smooth away trouble; and the rough male kiss

1 Like that of the Pre-Raphaelites, the Decadents, Symbolists and Parnassians.

2 *Discourses*.

3 *Dejection, an Ode*.

Of blankets ; grainy wood ; live hair that is
 Shining and free ; blue massing clouds ; the keen
 Unpassioned beauty of a great machine ;
 The benison of hot water ; furs to touch ; ”

What a chronicling of the smallest of small beer ! Though the novelty of it is now a great deal worn, it does need a poet's memory and art to hive the ill-related blessings of life in such wise that, after we have read his inventory, they are no longer a cloud of dull specks in the mind, but take on a phosphorescent glimmer. Brooke makes us feel in a new way “ the wild joys of living.”¹ Not only are we out of tune, say these poets, with these common domesticities, but with much of the glory and beauty of movement, say, in a football match, with its daedal dexterity and all that it means in the way of

“ A selfless flinging of self in the fray,
 Strength, compassion, control, the obeying of laws,
 Victory, and a struggle against defeat. ”

..... “ And for those who have eyes

The beauty of this is the same as the beauty of flowers,
 And of eagles and lions and mountains and oceans and stars.”²

(b) We have seen again a similar ‘renaissance of wonder’ in regard to the poetry of the English country-side. In filling the canvas of the mind with the teeming associations of the English village, perhaps no other poet in our time surpasses Edmund Blunden. Recall his *Old Homes*, his *Shepherd* or his War-returned Veteran among his apples and bees :

“ While through this triumph-song,
 As through the shielding leaves, the year's fruits burn
 In bright eye-cozening colour, turn by turn
 From cool black cherries till gold quinces throng
 Blossoming the blue mists with their queenly scent.”³

—an auriferous vein, of which Blunden has an abundant measure ; but so has he of pig-iron, too :

“ The sighing time, the sighing time !
 The old house mourns and shudders so ;
 And the bleak garret's crevices
 Like whirring distaffs utter dread.”⁴

Perhaps few poems approach Edward Thomas's *Lob* in the astute synthesis of diverse elements in the genius of the villager—his

1 Cf. Harold Monro's *The Week-End, Solitude, and Milk for the Cat* ; Siegfried Sassoon's *The Morning Express* ; and J. C. Squire's *Testament* (Stanzas 4 & 5).

2 J. C. Squire: *The Rugger Match*.

3 *The Veteran*.

4 *The Sighing Time*.

shrewd mother-wit and sagacity; his native spirit of independence and chivalrous championship of the weak against the strong; the mythologizing imagination whereby he evolves ætiological legends to account for the curious shape of hills and rock; and the homely friendliness with which he greets the familiar plants and birds of country-side, coining poetical or humorous nicknames for them, such as 'old man's beard', 'Love-in-idleness', 'milk-maids', 'Bridget-in-her-bravery', and 'Traveller's Joy'.¹ Modern regionalism, again, is responsible for several poems in which the poet sees a heightened beauty in his favourite spot or country.²

(c) Some of our moderns are explorers of beauty in strange landscapes. The Nature-pictures of John Freeman (1885-1930) are either grey and wintry or of the twilight and autumn or of the moon seen through bronze cloud-waves. What an exquisite creation of the mythologizing fancy have we in the lines from *The Evening Sky*:

"Rose-bosom'd and rose-limb'd
With eyes dazzling bright
Shakes Venus mid the twined boughs of the night;
Rose-limbed, soft-stepping
From low bough to bough
Shaking the wide-hung starry fruitage—dimmed
Its bloom of snow
By that sole planetary glow."

Sir J. C. Squire conjures up the vision of the rivers of the world with their storied memories and opalescent shadows, and of tropical forests, dark and mysterious with their gorgeous riot of colours and odours. The rugged grandeur cannot easily be forgotten of the stanza in *Rivers* describing the burst of the thunder-cloud on the scene and its aspect after the storm clears:

"Thunder in the dun dusk,
Rolling and battering and cracking,
The caverns shudder with a terrible glare
Again and again and again,
'Till the land bows in the darkness,
Utterly lost and defenceless,
Smitten and blinded and overwhelmed
By the crashing rods of rain."

The poet achieves indeed a marvellous fusion of imagination, memory and emotion in this poem, a fusion felicitously described by

1 Cf. also Francis Ledwidge's *A Dream of Artemis*.

2 Cf. Rupert Brooke's *Grantchester*, Hilaire Belloc's *The South Country*, Abercrombie's *Ryton Firs*, Drinkwater's *Warwickshire Song*.

Of blankets ; grainy wood ; live hair that is
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The poet achieves indeed a marvellous fusion of imagination, memory and emotion in this poem, a fusion felicitously described by

1 Cf. also Francis Ledwidge's *A Dream of Artemis*.

2 Cf. Rupert Brooke's *Grantchester*, Hilaire Belloc's *The South Country*, Abercrombie's *Rylon Firs*, Drinkwater's *Warwickshire Song*.

Arthur Waugh : "The river of song follows the course of the river of imagination, beckoning the fancy to a realm which is neither memory, nor anticipation, but something that hovers presciently between the two."¹ In *The Lily of Malud*, Squire makes us follow the maidens of an African tribe as they "with ecstatic terror dumb, steal fawnlike, through the shades, to watch hour by hour" the Lily of Malud as it unfolds in a little dark ravine, challenging the moon with a light of its own—"for the radiance it makes is as wonderful as death." The most elaborate poem on the moon in English poetry is perhaps this poet's. The moons of personal experience that shone on famous historic scenes, the moons of mythology and anthropology are here—and the moon, too, of astronomic ages hence when life will have ceased to be on earth. Squire loves to contemplate Mutability and vast sweeps of space and time without "losing his eyehold on the details of the Noah's Ark of life on the earth beneath him."² He can often pass, too, into a state of trance wherein is lost all sense of space and time. In *Niagara* he envisages an America of ages hence, depleted of Man, overgrown with forests, its cities gone.

"Fall'n, moss'd over, Niagara sounding on,"

In *The Birds* he reflects how through all the centuries of perpetually changing human civilization birds have remained unchanged in their habits and structure :

"O delicate chain over all the ages stretched,
O dumb tradition from what far darkness fetched."

Then there is W. H. Davies, who, for all he might be a super-tramp,—perhaps because he is one—devotes all his waking hours to the chase of beauty in bird and bee and flower, in woman and child, sea and sky, clothing them with the glory and freshness of a dream. Davies is a sort of Blake without mysticism and Wordsworth without didacticism and Pantheism. His poems—those that are not in the learned vein—are jets of pure joy in the familiar objects of Nature, gleaming with a lively fancy and carrying the power to allay the soul's drouth. No one in our time, unless it be that elfin genius, Walter de la Mare, dare attempt his staggering simplicity of utterance without achieving banal flatness. Listen to his confession :

"Cold winds can never freeze, nor thunder sour
The cup of cheer that Beauty draws for me
Out of those azure Heavens and this green earth—
I drink and drink, and thirst the more I see."

(*Seeking Beauty*)

1 *Tradition and Change*, p. 141.

2 Robert Lynd : *The Art of Letters*, p. 198.

The owl cannot prophesy for him the fall of Heaven's eternal lights, for when he takes his final walk on earth in "the thistled field of Age" he will make the owl's despair a thing to fill his heart with mirth. When he hears the cuckoo's voice he tastes of immortality :

"My joy's so great that on my heart
Doth lie eternity,
As light as any little flower—
So strong a wonder works in me ;
Cuckoo ! he cries, and fills my soul
With all that is rich and beautiful." ¹

"Come, thou Sweet Wonder," Davies apostrophizes the soul of Beauty in Nature :

"Come to my heavy rain of care,
And make it weigh like dew ; charm me
With Beauty's hair, her eyes or lips ;
With mountain dawn, or sunset sea,
That's like a thousand burning ships."²

He has no use for metaphysics, for his "Joy is in beauty not its cause" ³ and

"If I can pluck the rose of sunset, or
The moon's pale lily, and distil their flower
Into one mental drop to scent my soul—
I'll envy no man his more worldly power."⁴

In *Love Speechless* he says :

"I sit bewildered by those charms
That follow wave by wave all day ;
When I would with one wave make free,
The others take my breath away."

Subtle fancies, like shy birds, glance in and out of his verses ; and countless graces of thought and phrase without even the hint of literary pose. Davies is as great a nympholept of Beauty in Nature as she has ever had ; and yet in the presence of human sorrow and misery, a sudden twinge of pain smothers joy :

"When, with my window opened wide at night,
To look at yonder stars with their round light,
In motion shining beautiful and clear—
As I look up, there comes this sudden fear :
That down on earth, too dark for me to see,
Some homeless wretch looks up in misery ;
I close my blinds, and draw my body in.

1 *The Wonder Maker.*

2 *Come, Thou Sweet Wonder.*

3 *Rags and Bones.*

4 *The Song of Life.*

Still thinking of that Heaven, I dare not take
 Another look, because of that man's sake ;
 Who in the darkness, with his mournful eyes
 Has made my lighted home his paradise."¹

III

Let us take a poet whose vocation is the vivid and veracious presentation of the struggle for daily bread, of the grim lot of the toiler in the pit, at the plough and forge, in rough seas, and the portraying of the raw facts of untutored human nature—W. W. Gibson. Instead of burying his head ostrich-like in the sand, before these, he depicts them, like Hardy and Housman, without silver haze or rainbow fringe, or the soothing opiate of a far-off reminiscence or metaphysical consolation. At the same time, Gibson will not have the reader forget the splendour of the soul in its death-grapple with circumstance. This contrast between material failure and spiritual victory, what Gibson calls "Beauty and Terror"² provides the master-key to the understanding of his poetry. His yearning after Light and the hidden elusive meaning of things in this composite world of ours is revealed in *Windows* :

"But ever must my restless days be spent
 Following the fugitive gleam until I die —
 Light-shotten darkness, glory struck from strife,
 'Terror to beauty kindling, death to life."

and in the poem prelude *Daily Bread* :

"I caught the stormy summons of the sea
 Through whose unresting conflict day and night
 Surges the dauntless human harmony."

Each one of the seventeen scenes in *Daily Bread* illuminates an aspect of man's unconquerable mind, the unplumbed resources of his spirit in the way of heroic courage, silent self-devotion and love strong as death. The most moving of them all is *The Furnace*, wherein a dying stoker's child, thinking his father's delirious ravings are due to fright, asserts his own fearlessness and, when the ravings are hushed in death, says: "He isn't frightened now." In *The House of Candles*, a trance brought on by sunstroke enables Grizel Stark to vanquish the spiritual darkness in her soul begotten of hatred towards a faithless lover and a still-born child she had murdered in thought ; in her moment of illumination she not only sees her lost child but also regains Love. In several other poems Gibson makes use of 'delirium' to reveal what is latent in human nature and personality, its occulted

1 *The Two Heavens*. Cf. also "A. E." 's *Love* and Horace Shipp's *Rebel*.

2 In the sonnet, *Chambers*.

sides of romance and imagination.¹ In the three poems of *Borderlands* he 'studies' the ways in which the texture of a man's life takes its hues from the inner world, from his conception of what is lovely, grand or heroic. In *Queen's Crags*, for instance, an old hind reacting against the prosaic character of his wife indulges in a rhapsody over the circus gipsy-queen of his dreams, by way of antiphon to his young friend's hallucinations about Queen Guinevere. As they are talking, the Queen herself appears on the mountain crags, none else than the young man's flame, Peggy Haliburton. In *Hoops*, the crippled and deformed stableman of a circus, endowed with more than Greek love of physical beauty in repose and movement, rebukes his friend, a strapping clown who has children, for forgetting that sovereign blessing in his anxiety for their bread. The poem throbs with the Greek love of form.

Livelihood (a cluster of twenty poems) polarizes light on psychological moments in the lives of miscellaneous workers—pitman, orchestra-fiddler, petty shop-keeper, plate-layer, upholsterer, country-doctor, and so on—so as to reveal the contrast between the two planes of their existence, the imaginative and the physical. The upholsterer (*Makeshifts*) who has the soul of a poet and the talents of a painter solaces himself for his crosses in love and the boredom of his misfitting occupation by re-living moon-lit hours on the honey-scented heather, listening in memory to a girl's songs, and contrasting his lot with that of a shivering waif in the streets. He had lain in the heather "with the full moon blaze, hour after hour, bewildered and adaze, as though enchanted." With a sudden flash of inner light, like Abt Vogler he declares his conviction of the imperishableness of Beauty once realized:

"But things once clearly seen, once and for all
The soul's possessions—naught that may befall
May ever dim, and neither moth nor rust
Corrupt the dream, that, shedding mortal dust,
Has soared to life and spread its wings of gold
Within the soul."²

Most poems in *Beauty for Ashes* deal with physical objects and movements as symbols of "soul-fact." When little Audrey dances on the sea's edge the poet sees in it a prophecy of her power to ride every danger in life. The pitcher, the rocket, the ferret, the tyre,

1 E. g. *Holiday*; *The Night-Shift*; *Wheels*; *The Lighthouse*; *Solway Ford*.

2 The upholsterer has a family resemblance to the stone-mason in *The Dancing Seal (Fires)*, who plays on his fiddle all night long to the philharmonic seal; to the bed-ridden lad in *The Crane (Fires)*; to the old farm-labourer in *The Flute (Ibid)*; and to the old piper in *Livelihood*.

the adder, the boat, the cooling pig-iron, the purple orchis, the poppy's flame, the little red calf, the quarry,—each yields him some spiritual message or correspondence. They may be said to contain the poet's philosophy that the glory of life lies in adventure, the greatness of the soul in struggle, of character in fortitude; they embody his faith that Beauty is imperishable,¹ and 'Death that seems a dreamless sleep is but life' burning more fierce and deep';² they vibrate with the poet's joy of life, his feeling for the Beautiful and the wondrous dream-world of children.

IV.

From the "poetry of interpretation" let us turn to the "poetry of escape"—the poetry that strains its ears to catch unheard melodies and dreams of an existence from which the satires of circumstance are abolished, the poetry that yearns to shatter this sorry scheme of things entire and remould it to the heart's desire.³ Not much imagination is needed to sing of "Dream-prairies spread with flowers that never grew and breezes balmy then ever blew. . . . and deeper woods than traveller ever knew."⁴

More inspiring is the mood that evokes for us in a few strokes the picture of a life that realizes a rounded harmony of values, in which

" Old valours rise to share
Ordeals there ;
Near, like a wife,
Stands effort's outcome bodied fair,
Not fettered with dead thoughts, not fainting
Because the nightmare world hath lain
Athwart her hopes, but love acquainting
With beauty ever again."⁵

- 1 *Beauty for Ashes.* 2 *The Undying Fire.*

3 Also poetry, like that of J. E. Flecker, that dreams of the romance of far-off lands. An English disciple of the French Parnassians, Flecker carried in his veins the glamour and mystery of the Moslem East. He had affinities with Keats and Swinburne. His lines on Beauty

" Whose voice is like a waterfall
And sweeter than singing bird,"
and " Whose eyes are silent pools of
Light and Truth."

are characteristic of one who inherited his mantle from Keats, the Pre-Raphaelites, Pater, Oscar Wilde and the Aesthetes of the Nineties. Flecker's visionary eye was turned towards "lands where blaze the unimaginable flowers" and the Golden Journey to a Samarkhand not known to the geographer.

4. Squire : *The Unvisited*; he is not so commonplace in *Echoes*.
5. Sturge Moore : *The Land*.

of which the following is another facet :

" Here the high failure, not the level fame,
Attests the spirit's aim.

...
...

The obdurate marble yields ; the canvas glows ;

Perfect the column grows ;

The chorded cadence art could never attain

Crowns the imperfect strain ;

And the great song that seemed to die unsung

Triumphs upon the tongue."¹

But such definite cataloguings lack the haunting quality of lines that hint the profile of the far-off goal of human endeavour and fill us with a spiritual nostalgia for something beyond the sphere of our sorrow :

" Friends and loves we have none,
nor wealth nor blessed abode,
But the hope of the City of God at the
other end of the road."²

(b) Perhaps the most felicitous attempt in contemporary poetry to project this pilgrimage of the soul in the form of children's adventure through Nursery Rhymeland and Fairyland is that of Alfred Noyes. Remarkably varied are his themes, and brilliant his mastery of metrical forms and technique. Though he often shows a lack of creative power that renovates and strengthens our deepest thought and emotion, he can play on the keyboard of moods and tones and styles with a versatility that is rare in the poetry of our time. Through all these Protean moods and themes the poet's secret heart is never far away from the Beautiful in Art and Nature, in Man, his ideals and achievements. His Maeterlinckian fantasy, *The Forest of Wild Thyme*,³ is not so much a sequel to, as an improvement upon, *The Flower of Old Japan*. Seeking for their lost brother, Peterkin, who is to be found in the heart of the smallest

1 C. G. D. Roberts: *The Unknown City*.

2 Or the following well-known lines from W. B. Yeats, one of Masfield's early masters:

" All things uncomely and broken, all things worn and old
The cry of a child in the roadway, the creak of a lumbering cart,

...

Are wronging your image that blossoms a rose in the deeps of my heart."

3 The theme of this poem is the same as that of *The Blue Bird*.

Flower, the children come to rest awhile in a wild thyme snuggery, when they hear,

“ the luscious fluttering
Of flower-soft words that kiss and cling,
And part again with sweet farewells,
And rhyme and chime like fairy bells.”

—the words, Shakespeare's: “ I know a bank where the wild thyme blows ” etc. A humorous scene tells us of the “ Hideous Hermit ”—a Pecksniff of a spider—who is all tears for the grief he feels for his lost love whom he had loved “ with all the letters in the Chinese alphabet ” From his clutches the children are rescued and led on to the Temple of the Smallest Flower by a glistening fairy-host led by Pease Blossom and Mustard Seed. Pease Blossom tells them how to dull, sceptical old folk “ the Smallest Flower is furred, and mute is the music of the world.” Mustard seed asks them to imagine what the forest would look like if all the flowers that lit its thyme-bowers were turned to temples with many a pillared portal and domes that swelled to the sky. How foolish are those then who think that all must see the world alike and who scorn another creed ! One thing alone is constant here :

“ Love, that while all ages run
Holds the wheeling ages in one ;”

Through a mazy forest of Beauty the poet takes us to the Ivory Gate of Sleep. With a fine skill old nursery rhymes are made to diversify the piece and minister to the poet's hidden purpose :

“ Then we saw that the tunes of the world were one ;
And the meter that guided the rhythmic sun
Was at one, like the ebb and flow of the sea,
With the tunes that we learned at our mother's knee.”

When the children are about to enter the Temple of the Smallest Flower a voice is heard like that of the mother of God singing to a little child the cradle-songs of Eternity and answering his questions while he basked in her smile :

“ What does it take to make a rose, mother-mine ?
The God that died to make it knows
It takes the world's eternal wars,
It takes the moon and all the stars,
It takes the might of heaven and hell
And the everlasting Love as well,
Little child.”

The Statue, a similar parable, tells us of a prince who could see but fragments and gleams of Ideal Loveliness in all things—in

waves and flowers and winds, in books and dreams, in paintings and in music, in strange eyes and passing faces—and would therefore wed only the All-Beautiful. Wandering through his forests he is bewitched and kissed to death by the sculptured form of Anadyomene, the Queen of his dreams.

(b) Noyes is not the only poet who flings away from Edmund Gosse's or Miss Sitwell's general characterization of the moderns. There is the entire flock of Irish poets (whether you think of them strictly as Georgians or no) whose deep mysticism puts them in a class by themselves. And among others there are some who are occasionally, and even often, surprised by a mood far away from poets like Davies or Edmund Blunden. They can pass into a state of heightened consciousness similar to that serene and blessed mood in which

" We are laid asleep
In body, and become a living soul :
While with an eye made quiet by the power
Of harmony, and the deep power of joy,
We see into the life of things."

—a mood that lifts the veil from the hidden loveliness of the world. John Freeman's *Discovery* commemorates such a moment of intuition.

" Now thou hast blessed me with a great pure bliss
Shaking thy rainy light all over the earth,"

In *The Body* he yearns for this inner light. Dreaming of woman's beauty, the curves of whose form are like water, plunging to its pool, a falling spear of light,—“Water falling golden from the sun but moonlike cool”—whose “blood lit her body with lamps of fire and made the flesh glow that like water gleamed cold”, the poet slips from the dream of the seen to the unseen, to the contemplation of the eternal stream and flame of the Spirit :

“ If these eyes could see what these eyes have not seen—
The inward vision clear—how should I look, for joy,
Knowing that beauty's self rose visible in the world
Over age that darkens, and griefs that destroy ? ”

In a metaphysical passage, whose subtle and tenuous paradox is reminiscent of John Donne, J. C. Squire describes his vision of Beauty's self.¹ The Beauty of the physical world acts as mystagogue for leading the poet to a Higher, to what Shelley would call “Intellectual Beauty,”

¹ *Antinomies on a Railway Station* :

“Beauty herself her spell has broke,

...
That all things move yet all are still,”

"To the primal end of her journeyings,
Her ultimate and constant pole."

It is not only in this poem that the poet feels "a metaphysical arm" tearing away the darkening pall cast by the bright phenomenal and lifting him above a Time-Space World into the realm of the Eternal. He gives us in *Town* an ecstatic glimpse of the Beyond, echoing the experience to which the mystics of all lands bear testimony :

"The immortal feels for the immortal
The eternal holds the eternal by the hand
The last environing veil is lifted,
And lost horizons float into our view."¹

This same strain of Neo-Platonic mysticism is heard in Walter de la Mare's sonnet on Music :

"When music sounds, all that I was I am
Ere to this haunt of brooding dust I came."

His is an unquenchable hunger for a lost Paradise. "A lucid watcher of the temporal and the eternal, a catcher of the mysteries that fly in every mood of existence," he has moments when the Beauty at the heart of things seems to beckon him from moonbeam and star-sown sky, and betwixt breathing silences he hears voices whispering him, "Seek ! Seek !" The poem, *Voices*, is one that the author of *The Crescent Moon* might have written or any of the ancient South Indian "Alwars" (Vaishnava Saints). Tagorean, again, in its glancing lights of inner meaning, is *The Lamplighter*. *Sleeping Beauty* is a variant of *Voices*,—the poet here being the seeker and not the sought.

V.

The most prominent of the Irish mystic poets after Yeats and "A. E." is James H. Cousins.² An incorrigible worshipper of Beauty

1 The last stanza of *Starlight* and of W. J. Turner's *The Forest Bird*.

2 Born in Belfast in 1873, he has made India—except for his world tours—his home since 1915. His craftsmanship and sense of form he owes partly to the French strain in his blood, and partly to his own genius and apprenticeship to the great masters of poetic technique. In metrical versatility and skill Dr. Cousins can challenge comparison with any now professing the craft of verse. His diction and phrasing are frequently reminiscent, without any hint of derivativeness, of Shelley, whom he loves most among English poets; and his artistry has a Tennysonian finish without the sophistication. With all this Cousins is effortless and writes only when he is mastered by song. His imagery is marked by a grand spaciousness, pillaging its elements from Irish, Greek, Indian and Japanese mythology, from travel and a strenuously assimilative mind. But his genius and spiritual intuition notwithstanding, he has been systematically neglected by the reigning critics of English poetry.

in Nature, he regards her service as only a means to get at the absolute Beauty beyond. His poetry may be described as a handshake between the Divine Logos and the temporal world.¹

A *Hymn to Hidden Loveliness* gives the key to all that Cousins has written :

“ Whose is that voice whose far sweet sound
 Within the soul moves strangely near,
 Calling and calling, yet is drowned
 In silence when I turn an ear ?
 Whose is that face whose instant sight
 Pales the moist evenings’ crimson sky
 With something clearer than the light,
 And yet eludes the swiftest eye ?
 Whose is that hand whose white cool fire
 Shakes the rapt body overmuch
 With pangs of infinite desire,
 Yet slips beyond the keenest touch ?
 Spirit of utter Loveliness !
 Thine is the voice, the face, the hand ;
 Thine is the all-compelling stress,
 And thine the swift shape-changing wand.”

Tree Sacrifice embodies an original thought. A lofty tree’s top branches that had been shutting the snow-peaks from the poet’s eye are lopped off to his orders. No sooner is the thud of the branches heard than he feels a twinge of guilt “to see that regal thing discrowned.” But another and a deeper voice in him, speaking for Nature, answers that those who do a thing in response to a noble motive are pardoned, even were it to offend against Nature’s subtle laws in some unknown way. The motive (æsthetic or ethical) condones the error :

“ Get thou and spend in Beauty’s cause,
 But leave with me the reckoning.”

Nature has myriad forms of terror and beauty and is master of the simple power to sink a star or raise a sun. She is a sum of paradoxes :

“ Who listens well, my flowers will find
 No less articulate than birds.

¹ Quotation is difficult, as practically the best part of his work for the last thirty years would have to be quoted by way of support. But an attempt at selection must include :

The Goblet ; The Fan ; Transient Beauty ; Morning Worship ; The Girdle ; A Sun Sparkle at Sea ; Romance ; Tree-Sacrifice ; Life (two sonnets) ; Reaction ; Graven Images.

My rock is vocal as the wind.
 My silences are secret words.
 A myriad shapes, but one in soul,
 They come and go in shade and sun.
 My Beauty calls throughout the whole
 And all desire of me is one."

Reaction (written in 1929, at Hollywood) expresses the poet's revulsion from 'painted faces stalking trivial fame' and the shameless flaunting of mouldering flesh and all the blasé pursuit of pleasure. Retiring into the soul's sanctuary, he asserts his loyalty to the purer flame within. Mr. Cousins is among those few European students of Ancient Indian art who have been able to penetrate into its spiritual core. He has interpreted Indian art with the insight of one who carries the spiritual heritage of that art in his blood; and he has rendered homage to European art as well. In two beautiful stanzas of *Graven Images* he suggestively sums up man's evolution through art. In the second of the two sonnets on *Life*,¹ he laments that the spirit of the great artists from Praxiteles to Toscani should be threatened with extinction by the bellicose instincts of men. There are again two fine sonnets on Paderewski, which suggest a comparison with Maurice Baring's sonnets on Beethoven, Mozart and others. In translating the emotional effect of the music of great masters into pictures vivid enough to woo the painter's art, Baring shows a decided superiority. How few are the poems that interpret nobly and justly—and what is rarer, in phrases that carefully *distinguish* the effects—the genius of master-musicians! It is so difficult at once to characterize and to achieve the grand style. When we read in Alfred Noyes' *The Death of Chopin*:

"What harmonious
 Glad triumphs of the world's desire
 Where passion yearns to God, and burns
 Earth's dross out with its own pure fire"

do we not desiderate a finer characterization?

VI.

Speculations about the Psyche that apprehends Beauty, about its origin, its character, its evanescence, its destiny after the dissolution of the body; about the mystery of the thing that uses the intellect, the instincts, emotions and the sense of human fellowship as its servants; recollections of the sudden illumination of the soul by Beauty—what one may call its theophany—and its long trauancies, descriptions of its all perfect character, its living "effluence" even where it has departed

¹ Written in 1925.

from the face of things ; rapturous affirmations of its immortal character and gloomy denials thereof, and all moments between of the pendulum of faith ;¹—these form the theme of Masfield's sonnets.² The poet's philosophisings, when he attempts to trace the God in man to the Master Cell presiding over the million other cells of the body or grubs for the Spirit in the charnel-vaults of Matter, would not have been so amusingly idle had they come eighty years earlier. Pegasus is without wings so long as speculation keeps the saddle, but it does not always. Masfield is great when he describes the *mysterium tremendum* in Man and makes humanity one, in spite of race, colour and creed, which enables the mind of man not only to triumph over dangers and disasters, when tempests harry half the planet's girth and Death's seeds are scattered everywhere but create the wonderful fabrics of Science, Philosophy and Art, in which

“ he can live again
Eternal beauty's everlasting rose
Which casts this world as shadow as it goes.”
It is the power that comprehends the skies
“ That, without moving, knows the joys of wings,
The tiger's strength, the eagle's secrecy,
And in the hovel can consort with kings,
Or clothe a God with his own mystery.”

If the poet could but grasp this, “ Joy with searing-iron would burn him wise.” In the sonnet which closes with the triumphant declaration, “ but we who breathe the air, are Gods ourselves, and touch everywhere,” he rings out paradoxes that mock the atheist, whose part he has played elsewhere.

Interesting musings are interspersed. Is the perception of an all dissolving glory the sudden act of a moment—“ the unfeeling mud stabbed by a ray cast by an unseen splendour's great advance ”?—Or is it a long and tardy growth, crumb by crumb, like the coral reef? Again, does Beauty dwell in the mind, or in external objects?

There are quaint hypotheses about quickening planetary influences on man's growing consciousness of Beauty. Masfield is not satisfied either with this more or less abstract homage to it, or with his fleeting glance at it in *Dauber*. He writes a lovely parable, *King Cole*, to show how Beauty (which sums up for him Knowledge, Imagination, Love and all other values) can transform the world. Marching to the King's flute, the people of the city think,

1 These speculations closely recall cantos 41-56 of *In Memoriam*.

2 In *Lollingdowns and other poems, with Sonnets*.

“ We go to see
 Life, not the daily coil, but as it is
 Lived in its beauty in eternity,
 Above base aim, beyond our miseries ;
 Life that is speed and colour and bright bliss,
 And beauty seen and strained for, and possessed
 Even as a star forever in the breast.”

VII.

In *The Testament of Beauty* Bridges tries to show the place of Beauty in the whole economy of thought : “ how it is to figure in our religion ; by what steps the highest conceptions of it have grown up ; and at what points in the course of ‘emergent evolution’ the sense of beauty has been markedly quickened in mankind. He thinks of a driving force that presses for ever upward through the atom, through the organism, and then through all human experience, sensuous, æsthetic, rational and spiritual. In this process beauty becomes, ever more and more, consciously valued, as well as perceived and expressed”. The poem is a synthesis of science, philosophy, religion and poetry. In its progress it glances at modern physics, biology, psychology, historical periods and epochs of culture, at diverse arts and art history, besides embodying more than half a century of reflection and experience.

Georgian poetry keeps philosophy at arm’s length. It refuses to concern itself with the problem of a Divine Intelligence behind phenomena. No contemporary poet, except Bridges, seeks or has sought to harmonize into a system the scattered fragments of modern thought in science, philosophy and religion. In *The Testament*, Bridges, like Milton, Wordsworth, Browning or Tennyson, is concerned with the welfare of the soul ; though he does not employ for his purpose the trappings of the literary epic, or of allegorical machinery or the framework of spiritual autobiography.

In *In Memoriam* Tennyson wrestled with scientific doubt and sought to re-establish on a firmer basis Faith that reeled under the hammer-strokes of evolutionary biology. To Bridges, however, this conflict between Science and Religion does not exist, for he writes in an age that is aware of the boundary lines and the respective limitations of the two. Tennyson was faced by the antithesis of sense and soul, and he sought to ‘shadow forth’ sense at war with soul. But to

1 Oliver Elton: *Robert Bridges and The Testament of Beauty*. The argument is given in the writer’s article on *Religion in Contemporary Poetry* in *The Scholar Annual* for 1933.

Bridges, as to Browning, Spirit and Flesh, sense and soul, are aspects of an indivisible unity :

Let us not always say
 "Spite of this flesh today
 I strove, made head, gained ground upon the whole !"
 As the bird wings and sings
 Let us cry "All good things
 Are ours, nor soul helps flesh more now, than flesh
 helps soul !

Bridges regards Beauty as subsuming all other values.

Every page of *The Testament* bears witness to the poet's lively interest in the modern world, its inventions and curiosities,—aeroplanes, the wireless, the latest discoveries in Mesopotamia, the newest types of agricultural machinery, the post-War undergraduate, Freudism—and there is a whole book upon the subject of sex. The poet brings to all these a free speculative spirit ; and his considered views on all are those of one who knows the strength and weakness of the two ages, the Victorian and the Post-War Modern, which were his. He bridges the ages by means of a philosophic independence and wisdom that refused to swallow the catchwords of the hour. He rises equally above Victorian conventionalism and modern *carpe diem* and deification of complexes.

Tradition and Experiment are blended in equal degree not only in respect of theme and outlook but also in that of the metre he has adopted, which reconciles the utmost freedom with the rhythmic pattern calculated to induce expectancy in the reader. The same stamp of individuality is seen in the diction and in the magic phrases carrying appeal to the scholarly imagination or throwing open vistas in the mind. The poem is incrustated with metaphorical expressions that evoke pictures in the mind. "The brave buds of March drinking the valiance of the sun's steepening rays" ; "pink bunches spreading their gold hearts to the sun ;" "October's flaming hues surcharging the brooding hours, till passionate soul and sense blend in a rich reverie with the dying year" ;—illustrate the golden insets. Though there are several passages not subdued by poetic power, it is inlaid, like a piece of marquetry, with clusters of lovely nature-painting, epic similes, illustrations and *obiter dicta*, all diversified by 'moments' from the tapestry of cultural epochs.

VIII

Every poet, ancient, mediæval or modern, seeks to *communicate* his experience of life and his response to the murmurs of things, in

words that blend melody with suggestion. As beauty enters into his form, so should it, in some way, run like a living chord through his matter. The character of the things he sings about may, and ought to, vary according to the character of the age or epoch of culture and civilization, which is his milieu or of which he is the exponent. His art and theme would vary according to his genius ; the degree in which he accepts, or reacts against, tradition will depend upon his temper ; but whatever the poet's genius and temper, a radio-active element, in the shape of beauty, must animate the soul and body of his writing in some form or other. We have seen the play of this element in the work of contemporary poets of all schools, in the adherents of tradition as well as in those who are tally-hoing after new literary fashions and fads.

R. SADASIVA AIYAR.

SOME ASPECTS OF TRAGEDY.

Definitions are rarely satisfactory. It is difficult to write a fully comprehensive definition without being clumsy. But for all practical purposes we know that Tragedy is a conflict between two opposing forces ensuing in the destruction of the party with which the audience sympathises. Bearing this definition in mind if we trace the history of Tragedy in its various periods we shall find that our conception of Tragedy is intimately connected with our attitude towards natural phenomena, science, superstitions and social organizations.

I

In the ancient literatures of the world Tragedy was conceived as a conflict between Fate and Man. In the early stages of civilization when science had made very little progress natural phenomena were magnified to the position of demi-gods who inspired awe and fear in the minds of the people. Vedic and Scandinavian gods were thus conceived. Aruna was the god of dawn. Indra was the god of thunder who sent forth his lightnings and thunder and fought the demon of drought and inclement weather. The Scandinavian gods and their fights, like the Vedic gods and their fights, are personifications of natural phenomena. The killing of Balder, the Norse god of light, by Loki, the god of evil, is a Sun-myth—the slaughter of the luminary by the malevolent powers of winter.

The Greek gods also were personifications of these natural phenomena and of the awe and fear produced in the mind of man. The struggle of the early man against his adverse environment and the cruel, untamed and unconquered elements made a great impression upon all creative writers with imagination. These adverse circumstances, these destructive elements, the Greeks called Fate or Nemesis—the goddess of vengeance. The Greeks were intensely superstitious in their dread of Nemesis, and thus in all their tragedies this idea of Nemesis or Fate overtaking a man plays a very important part. In a Greek tragedy the source of tragedy is not jealousy as in Othello, or irresolution as in Hamlet. Character does not play a very important part in a Greek tragedy. It is not a conflict between character and character or between two aspects of the same mind as in Hamlet and Macbeth but a conflict between Man and Fate—Fate pursuing a man or even a family for an act of pride,

presumption or an ancestral crime. This idea of Fate determining the destiny alike of men and gods is the prevailing note of Greek tragedy. Self-respect demanded that men should accept the decrees of Fate without protest. Thus to the Greek mind man stood alone and unaided in the world, fighting against adverse circumstances and surroundings of weather, superstition and ignorance. Like most men of his generation Aeschylus, the first of the great Greek dramatists, grew up obsessed with the conviction of the impossibility of escape from the Fates and Furies that pursue the steps of men. As is proper in the early stages of civilization there is no love interest in the plays of Aeschylus. He is interested in elemental forces like Fate, Fear, Justice and Revenge. In his play *Agamemnon* the Greek Prince is compelled to sacrifice his daughter for the general good. But this evokes hatred in the mind of Clytemnestra, his wife. She is the minister of Fate, the minister of Justice, the typical Fury of the Greeks.

Clytemnestra says :—

Aye ; call not this deed mine. Thou seest here
No wife of Agamemnon, mortal clay,
But an avenging spirit sent from heaven,
To wreak God's vengeance on a guilty line.

It is obvious that this is not a tragedy of character as we find in the plays of Shakespeare. The tragedy is due to the dual workings of Nemesis and the ancestral curse.

King Oedipus of Sophocles is also a typical Greek tragedy of fate. It was prophesied—we can almost say decreed—that Oedipus would murder his father and marry his own mother. The inexorable fate brings about this tragedy when young Oedipus kills his own father Laius and marries his own mother Jocasta, Queen of Thebes. When Oedipus discovers his own crime he puts out his eyes and Jocasta hangs herself. This is not a tragedy of character but of Fate—the inscrutable workings of Nemesis. The tragedy is not the result of any flaw in the character of Oedipus. We see some development in the art of tragedy, for there is far greater humanity in Sophocles' tragedies than can be found in Aeschylus, but even in Sophocles men remain "the playthings of the gods."

Euripides, the youngest of the Greek tragic dramatists, is a link between the pure Tragedy of fate and the Shakespearean Tragedy of character. He chose men and women, not gods, for his dramatic personae. There is acute analysis of character in Euripides. Professor Gilbert Murray calls him "the classic Ibsen" because of his complete understanding of women. His *Médeia* is a tragedy of character and situation. Jason grows weary of his sorceress-wife

Medea who had helped him in getting the golden fleece. He wants to marry the daughter of the King of Corinth. Medea becomes jealous and decides to murder her rival and then her own children. The moral is that ingratitude should be punished. Punishment follows sin. Wrong leads to disaster.

But even in *Medea* character is not destiny as in Shakespeare. Here the important idea is the moral idea of gratitude. Here it is Fate which overtakes the wrong-doer. But in Shakespeare Hamlet is innocent, Othello is innocent, Lear has committed no crime. Still all of them suffer not because Fate pursues them but because they have some weakness or defect in their nature.

Thus on the whole the Greek tragedy gives us an impression of a tragic conflict between man and the inscrutable, unknown forces called Fate or Nemesis.

“As flies to wanton boys, are we to the gods;
They kill us for their sport.”

II

Nearly two thousand years later we come to the Elizabethan age—the greatest age of the drama in the history of world literature since the age of Pericles and the Greek dramatists. Science and civilization had advanced and the natural phenomena had ceased to inspire a superstitious fear. Instead of gods and demi-gods ruling the world like wanton boys we have one Supreme Being directing the affairs of the Universe. After the Renaissance man is interested not merely in Fate and its vagaries but in Man and his character. After the discovery of America and the defeat of the Spanish Armada Man is no longer looked upon as a helpless creature fighting heroically but helplessly against inscrutable and relentless Fate. Hamlet expresses the Renaissance ideal when he says “What a piece of work is Man! how noble in reason! how infinite in faculty! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals!”

Thus in Shakespearean tragedies man is no longer a mere plaything of the jealous and warring gods. If there is a tragic conflict it is between man and man, between character and character, between two aspects of the same character. Thus we can say that in a Shakespearean tragedy “character is destiny,” or as Bradley puts it the centre of the tragedy lies “in action issuing from character or in character issuing in action.” In Shakespeare the main source of the tragic deeds is character. This does not mean that there is no element of Fate in a Shakespearean tragedy. Fate plays a minor part in the tragedy

of the period, although the idea of fate is not altogether absent. Romeo never received the friar's message about the potion, Edgar arrived too late to save Cordelia, Desdemona dropped her handkerchief at a critical moment. These are some of the instances of the intervention of Fate in the tragic affairs of men in Shakespearean tragedies. But in spite of these instances of Fate as a tragic factor Shakespeare gives us an impression that the final result would have been the same even if Fate had not intervened and that the tragedy is due to character and not fate. *Hamlet* is the tragedy of an inward conflict, the tragedy of a moral nature in conflict with his coarse, vulgar and superstitious surroundings. *Othello* is purely a tragedy of character—simple, credulous, magnanimous husband duped by a villain. *Macbeth* is a tragedy of an ambitious character. The supernatural element is introduced to emphasise Macbeth's ambitions and guilty character. Banquo is free from it. *King Lear* is the tragedy of a vain old foolish king who gives up his authority for the sake of his whim although he is morally incapable of resigning his power. Thus in all the great tragedies of Shakespeare, although the element of Fate or Destiny is not absent, the principal source of tragedy is character and not Fate.

III

The next great age of the drama is the Twentieth Century. When we come to the modern period Science and the scientific outlook on life have developed so much that the idea of Fate altogether disappears from the conception of a tragedy. The modern age is too scientific to believe in the stars guiding the affairs of men. Civilization has become too complex and too mechanical to remain human and personal. Modern great writers like Galsworthy, Shaw, Masfield and others see tragedy in the fact that the modern social organization is too mechanical, too impersonal and too relentless to protect individuals, who are misfits in modern life. They say that we—as members of the social organization—commit unpardonable crimes under the impulse of the "herd spirit" against those individuals who from weakness or some personal idiosyncrasy, do not fit into the standardised and almost mechanical requirements of our social and industrial system. Galsworthy himself described this attitude in a letter to his American friend who had criticized his play "Justice". The author wrote "The play is a picture of the human herd's attitude toward an offending member—heads down, horns pointed—and of its blind trampling of him out. 'Justice' is a machine that, when some one has once given it the starting push, rolls on of itself.....". In "The Silver Box" the poor creatures Mr. and Mrs. Jones are set

against the power of organised institutions and their struggle ends in inevitable disaster. Here the character is not the essence of the tragedy. No one is guilty of any particular villainy. But the individual comes in conflict with the machinery of the law, and in the end we get an overpowering sense of the inequalities of modern life and of the inadequacy of our social machinery. As the magistrate says, Jones and his class are a *Nuisance to the Community*. "Strife" deals with the conflict between capitalism and labour. *Justice* is Galsworthy's indictment of the relentless machinery of law. In "The Escape" we have the same author's favourite theme of the clash between the individual and the modern machinery for the administration of justice. Captain Matt Denant in trying to save a girl in the Hyde Park finds himself a victim of law. After various attempts at escape he gives the game up. Galsworthy is not the only modern dramatist who has conceived tragedy in this new light. Bernard Shaw's *Saint Joan* also is a tragedy of a conflict between Joan the individual and the relentless, ruthless, and unimaginative machinery of the Roman Catholic Church and the feudal organization of the Middle Ages. In one sense *Saint Joan* is a tragedy of character as in Shakespeare. But Shaw has pointed out that this is not a conflict between one individual and another individual or a group of individuals but a conflict between one individual and the organised selfishness and the instinct for self-preservation of the society. He points out in the Epilogue and also in the Preface that if a Joan were to appear now we would treat her in the same way. Nan's outcry, in Masefield's *The Tragedy of Man*, "They be all against me! The 'ole world be against me", expresses very well the tragic conflict in a modern tragedy.

Thus we see that in the Twentieth Century tragedy results not from a Man's conflict with Fate, nor from a conflict with another character, but from a man's conflict with the soulless machine of the social organization.

D. A. DHRUVA.

JAMES JOYCE AND THE FUTURE OF LITERATURE.

It is notable how Irishmen are eminent among living writers of English. To assert that Mr. Yeats, Mr. Shaw, and Mr. James Joyce are, in their respective departments, the greatest British writers living, might not be true, but it would be an arguable proposition, and one with strong arguments to support it. Mr. Shaw and Mr. Yeats are now respectable and established figures, but Mr. Joyce is not so generally admired, and is rather the idol of a highbrow few. This is not surprising, for his early works, though meritorious, are not astonishing; his *magnum opus* is banned and inaccessible; and his latest efforts are largely unintelligible. His development has been almost continuously from the traditional and normal to the advanced and individual. His latest work seems to illustrate a tendency going on in modern literature, a tendency which is working towards a completely new sort of literature, but one in which the possibility and desirability of success are both doubtful.

Mr. Joyce is now about fifty years old. No one who has read his books denies his very extensive learning and great intellectual power. The merit of his earlier and less unusual works is more than enough to justify one in taking his later efforts seriously, and inquiring into their significance; and the question 'What is likely to be the outcome of these new developments?' is of great interest.

His first work of any importance was *Chamber Music*, a volume of poetry published in 1907. The verse in this is very musical, some of it is charming poetry, and as a whole it is reminiscent of minor Elizabethan lyric and entirely in the English poetical tradition. In 1914 *Dubliners* was published, though it had been ready ten years earlier. It is a book of short stories, written in the French tradition of Flaubert and De Maupassant, though with a rather more eloquent rhythm and sympathetic emotion than is usual with them. It contains, in *The Dead*, one of the best short stories of this century. In it he begins what he has not given up, the practice of introducing real places and people by name. This, though not scandalous, was chiefly responsible for the delay in publication. The book shews power of style, power of psychological analysis, particularly of emotion, and a rather meticulous realism; but it shews no sign of the direction these qualities were to take in his later writings. Here he is primarily a realist of the French school, and perhaps nearer to George Moore in *Esther Waters*, than to anyone else.

The same qualities appear, but with a difference, in the largely autobiographical *A Portrait of the Artist as a Young Man* (1916). It is the story of the life of Stephen Dedalus from his earliest infant recollections to his final break with the Roman Catholic church and the priesthood for which he had been intended. The outline of the story is the same as that of the author's life, and many if not all of the details must be the same also. The difference between this and *Dubliners* is partly in the impression it gives that the author has now set his feet firmly on the path he intends to tread, and partly in the fact that he is now directing his gifts not only towards a subject, himself, with which he is very intimately acquainted, but also to the treatment of the emotional workings of adolescence and youth, with which he had already hinted his competence to deal. *A Portrait of the Artist* is certainly the best of those novels, describing the childhood and youth of an unusual young man, which were frequent and esteemed in the pre-war years of the present century.

In *A Portrait of the Artist* Mr. Joyce's achievement was to call poetry to the aid of psychology. Most other realists, however masterly their command of style, have, even in their highest flights, had description and statement as their objects. In *A Portrait* something of another method, the method of much poetry, can be seen. The attempt is not so much to describe or state, or to convey, as to evoke or *give* (rather in the sense in which things are said to be *given* in perception) the knowledge of mind which the author wishes his reader to acquire. The quotations which follow illustrate this.

"His fellowstudent's rude humour ran like a gust through the cloister of Stephen's mind, shaking into gay life limp priestly vestments that hung upon the walls, setting them to sway and caper in a sabbath of misrule. The forms of the community emerged from the gustblown vestments, the dean of studies, the portly florid bursar with his cap of grey hair, the president, the little priest with feathery hair who wrote devout verses, the squat peasant form of the professor of economics, the tall form of the young professor of mental science discussing on the landing a case of conscience with his class like a giraffe cropping high leafage among a herd of antelopes, the grave troubled prefect of the sodality, the plump roundheaded professor of Italian with his rogue's eyes. They came ambling and stumbling, tumbling and capering, kilting their gowns for leap-frog, holding one another back, shaken with deep false laughter, smacking one another behind and laughing at their rude malice, calling to one another by familiar nicknames, protesting with sudden dignity at some rough usage, whispering two and two behind their hands."

" And yet he felt that, however he might revile and mock her image, his anger was also a form of homage. He had left the classroom in disdain that was not wholly sincere, feeling that perhaps the secret of her race lay behind those dark eyes upon which her long lashes flung a quick shadow. He had told himself bitterly as he walked through the streets that she was a figure of the womanhood of her country, a batlike soul waking to the consciousness of itself in darkness and secrecy and loneliness, tarrying a while, loveless and sinless, with her mild lover and leaving him to whisper her innocent transgressions in the latticed ear of a priest. His anger against her found vent in coarse railing at her paramour, whose name and voice and features offended his baffled pride: a priested peasant, with a brother a policeman in Dublin and a brother a potboy in Moycullen. To him she would unveil her soul's shy nakedness to one who was but schooled in the discharging of a formal rite rather than to him, a priest of the eternal imagination, transmuting the daily bread of experience into the radiant body of everlasting life.

The radiant image of the Eucharist united again in an instant bitter and despairing thoughts, their cries rising unbroken in a hymn of thanksgiving.

Our broken cries and mournful lays
 Rise in one eucharistic hymn
 Are you not weary of ardent ways ?
 While sacrificing hands upraise
 The chalice flowing to the brim.
 Tell me no more of enchanted days."

In the first passage Mr. Joyce is not merely describing the thoughts that pass through his hero's mind, when his neighbour's joke comes suddenly upon him as he dreams away a mathematics lecture; he is also trying to evoke in the reader's mind a similar confusion of imagery and thought. In the second also there are parts obviously intended to suggest rather than to describe. Although it tells the thoughts that passed through Stephen's mind, it also, metaphorically, so to speak, symbolizes his state of mind, and tries to evoke, if not a similar state, at least a sympathetic mood in the reader.

The autobiographical nature of *A Portrait of the Artist* is of use to the author, whose objectivity was already strong: it made it easy for him to be sympathetic, while remaining unsentimental; and that sympathy probably encouraged him to unleash "the spaniels of the imagination" and to risk giving play to eloquence and rhythm in his style. The style shews some slight adaptation to the age of the hero

a the book progresses—it begins with baby-talk, to express the child's earliest consciousness, and ends with a passage of poetic prose as, rather self-conscious, Stephen Dedalus stands on the threshold of manhood, half afraid of the world, and half eager for it. Here, Mr. Joyce tries to give the mind of his character as well as to describe it; and he meets with a fair measure of success, although, partly from the greater difficulty of what he is trying to do, and partly because he has not yet developed a technique for his purpose, *A Portrait of the Artist* is less agreeable reading than *Dubliners*. But there is more to be got from it by taking thought. In Wordsworth's earlier poems one feels his reactions to Nature are already established, even without the confirmation of the *Ode* and *Tintern Abbey*; but his power to describe those feelings is not yet developed—he has not yet found his technique. The same is true of Mr. Joyce. Like Wordsworth, he wishes to express what is not readily expressible in the linguistic convention of his time. At first, like Wordsworth, his subject develops as his power to express it increases; but, after a time, Wordsworth's subject ceased to develop, while Mr. Joyce's has not ceased yet. Wordsworth's subject was, we may say, his experience in the presence of Nature, and its implications; Mr. Joyce's is the emotional-rational complex of individual human minds. In one sense, it is not new: many poets, and especially Shakespeare and Donne, have dealt with it; but not in the same way. It was only a part of Shakespeare's cosmic vision, who presents his emotions rather by the dramatic stimulation of sympathetic emotion in his audience than by the mere presentation of emotional states in his characters. Mr. Joyce does at times shew sympathy, but he is not concerned to evoke it in his readers, nor does he often do so: he cannot be read uncritically, even when he seems to be carrying one away. This is due to his non-dramatic method, his more limited purpose, and his intensely detailed view of life, rather than to any incapacity for the expression of emotion or emotional expression.

In *Olysses* (1922) he evolved a method which, though in many ways open to objection, suited what he was trying to do. Here he shews his kinship with, if not exactly resemblance to Shakespeare and Donne. He has variety of approach, intensity of imagination, and illumination of phrase. He has the same power as they of holding both emotion and reason, subjective and objective, in balanced prominence. But he is often guilty of a fault which Donne never, and Shakespeare only in his universal humanity, shews—he is not merely obscure, but his meaning, one feels, is incapable of discovery. It is true that certain people have held that the meaning of *Protestant* in Herrick's *Bid Me to Live* is unknown, and that that is the glory of

the poem—but they are wrong, for even if it be admitted that the meaning is not expressible in other words, it can be felt and understood without them. Mr. Joyce's meaning in some parts of *Ulysses*, even though re-reading often brings light into darkness, can neither be felt nor understood, except (in charity let it be said) by himself.

Ulysses attempts to represent fully the life of a Dublin Jew, an advertisement canvasser, during the twenty-four hours of June 16th, 1904. This, described thus simply, is the usual impossible intention of the 'realist', but, though no other has so nearly approached that ideal, Mr. Joyce is far from being a 'realist'. He does not believe it theoretically possible, or practically approachable, to describe the whole of human life directly in words. The realist is inclined to think of life as limited to what words can directly express, and shews his originality, not in the description of what was thought indescribable, but in the description of what is not usually described. This is why *realist* and *indecent* so often go together. In *Ulysses* Mr. Joyce falls short, in mentioning the unmentionable, of Rabelais only; but this is not caused by his realism. It is due to his belief that "the mind of the artist should be arrested and raised above desire and loathing". Whatever he feels germane to his artistic purpose, of that he freely makes use. His effort is to represent (or imitate, or express) human life through individuals, not by recording it all, but by selection, artistic and impersonal; and he carries impersonality so far that all characteristics of humanity are equally valid for his purpose. The unmentionable has no larger place in *Ulysses* than in life, and he is right when he presumes that he cannot do without it if he is to carry out his intentions. Some think that therefore his intentions are wrong; and some do not think so.

If *Ulysses* is a stage in its author's development, as it obviously is, then its realism is an accident not essential to that development, which is altogether away from realism. That Mr. Joyce should have tried to imitate, with unusual completeness, twenty-four hours of a man's life, and included much which other writers would have left out, does not make the work realistic. *Ulysses* is, in fact, a very artificial product. In construction it is not only modelled on, but reflects in considerable detail the *Odyssey* of Homer, to which its episodes distortedly correspond, and many of its characters and its incidents. To each episode he has further appropriated an organ, an art, a colour, a symbol, and a technique, according to Mr. Stuart Gilbert's analysis. This book,* which has Mr. Joyce's approval, seems to read more in the work than is there, and to systematize in an

* *James Joyce's Ulysses*, by Stuart Gilbert. (1930)

impossible way; but even allowing for a considerable amount of extravagance and ingenuity in the interpretation, there can be no doubt that the symbols, colours, and arts are harped upon in a very striking way, and often become what seems an unnecessary cause of obscurity. This cross-word-puzzle intention, which runs through the whole book, is of no direct advantage to the reader, and very often might be put in 'just to make it harder'. But I think it had its use for the author. Just as the necessity of struggling with a difficult form has often been of great value to a poet, so the following of the *Odyssey* may have done more for *Ulysses* than shews on the surface. It has been said that painting and sculpture have an advantage over literature in the soothing and restful effect that the exercise of manual dexterity has on the mind. In modern life detective stories and cross-word-puzzles often supply a similar need. Perhaps this often misplaced Joycean ingenuity may have helped considerably in the composition of a very long and complicated work, and acted as a clue through a maze between the parts of which there is often no more apparent connection than between the desultory facts of everyday experience. Since, also, symbolism is a characteristic part of his method, emphasis on it is not surprising. *Ulysses* tells a story, but is in no way dramatic, and the possible dramatic implications of the story are hidden by the way of telling. The correspondence with the *Odyssey* may act as a framework which supported and strengthened the mass while it was setting and hardening.

The three main characters in *Ulysses* are Leopold Bloom (Ulysses), his wife Marion (Penelope), and Stephen Dedalus (Telemachus), the autobiographical hero of *A Portrait of the Artist*. First the morning occupations of Stephen and Bloom are described. Stephen rises, watches a friend bathe, breakfasts. Bloom rises, breakfasts. During the day Stephen teaches in a school, walks by the sea-shore, has a literary discussion in a publichouse, and joins in a drinking-bout with some medical students in a maternity hospital. Bloom goes out on his rounds, attends a funeral, visits one or two publichouses, also goes to the sea-shore, and, going to the hospital to inquire for a friend who is in labour there, joins Stephen and the medical students. Bloom, rather drunk, Stephen, very drunk, and a few medical students, drunk, visit the brothel district, and, after some adventures, Bloom and Stephen return to Bloom's house. Stephen goes to sleep there, and Bloom conveys to his wife, who approves of it, the idea that Stephen should lodge with them. The last forty-one pages are occupied with the train of thought which this starts in her mind as she is going to sleep: when she falls asleep *Ulysses* ends.

These are not extraordinary events. What is extraordinary is

the wealth of detail, especially mental detail, with which they are given. Not all the thoughts, but the large number necessary to communicate the rational-emotional complexes of the main characters are told. This mass of detail is made all the more complicated by great freedom of reference and allusion to both mental and physical events, past, present, and future. Some are even to things told in *Dubliners* and *A Portrait of the Artist*. And as Bloom's mind is full of miscellaneous information and inquiry, while Stephen's has much out-of-the-way erudition mixed with a strange violence of emotion, it is exceedingly hard to keep track of it all.

Mr. Joyce's varied career is partly responsible for this. Brought up and trained with the intention that he should enter the Society of Jesus, for which he was considered a most promising candidate, he revolted against the church, but not before he had learned enormously from his Jesuit education. He has been a teacher of languages, the manager of a picture-house, a medical student in Paris, and a wanderer through Europe; and his mind contains nearly such a farrago of learning as Robert Burton's. In spite of all this, the peculiar and indescribable atmosphere of Dublin's Bohemia has left its mark on him. He is always a Dubliner. All his miscellaneous learning, and all his 'peculiar and extensive' knowledge of the city of Dublin he has pressed into service in *Ulysses*, the annotation of which is going to offer a Herculean labour to some future scholar.

His method of reference is often very difficult, for it is reference *sub specie individuae mentis*; it does not come directly, but in its place as part of the consciousness of the character with whom he is dealing. This is most noticeable with the very literary content of Stephen's mind.

He continually presents mental and physical events so mixed up that they cannot be immediately distinguished, and sometimes cannot be distinguished at all; and the physical events are either presented through the minds of his characters, or when they are narrated, usually disguised by one of the highly stylized narrative forms which he uses. One episode is told in terms of the most fantastic exaggeration, another is in the language of the woman's column in a provincial daily newspaper, and a third is in a series of parodies of English style of many successive periods. One common method of his has been called "interior monologue". He himself has said that this is derived from *Les Lauriers sont Coupés*, (1887), by M. Edouard Dujardin, but since it consists in giving both external and internal events as they pass through one person's mind, there is really nothing remarkably new about the idea. What is new is the deliberate confusion between them. Mr. Joyce does not try to interpret the minds

of his characters to his reader, but to give them in process of working. What makes much of *Ulysses* obscure is this very confusion of subjective and objective, of conscious and subconscious, which is rationalized and analysed away, for the sake of clarity, by the psychological novelist, even if he means it to be interpreted into confusion again by the reader. We are so used to simplifying the mental workings of ourselves and others into something rationally intelligible, that when they are presented to us in something like their native incoherence, we do not easily understand them. And if we are not ready enough to make this simplification, language often forces it upon us, even in poetry, although poetry does succeed wonderfully in expressing emotions and mental states by means of rhythm, association, and evocative language generally. Poetry has not, however, done much to express those petty emotions which are too little and mean to have the character and force that call for poetic expression, and which scientific treatment falsifies by clarifying. Mr. Joyce tries, like the poet, to develop his meaning fully by means of poetic methods, but he applies them not only to the unpleasant, which is not new, but to the petty, mean, and sordid, which is. There are nobility and higher poetic qualities in *Ulysses*, but as he tries to keep much the same proportion as human life, and makes his artistic selection similarly proportionate, they are not very frequent. He also carries the poetic method to extremes which even poets rarely use. With most poets, even with Shelley, one feels that an effort has been made to give the words a rational meaning, even when the evocation is plainly the more important part of the effect on the reader, but Mr. Joyce often produces what is completely meaningless, and seems to be depending entirely on evocation to produce his effect.

I quote four passages from *Ulysses* in illustration.

"He saved men from drowning and you shake at a cur's yelping . . . Would you do what he did? A boat would be near, a lifebuoy. *Natürlich*, put there for you—would you or would you not? The man that was drowned nine days ago off Maiden's rock. They are waiting for him now. The truth spit it out. I would want to. I would try. I am not a strong swimmer. Water cold soft. When I put my face into the basin at Clongowes*. Can't see, who's behind me? Out quickly quickly. Do you see the tide flowing quickly in on all sides sheeting the lows of sand quickly, shellcocoacoloured? If I had land under my feet. I want his life still to be his, mine to be mine. A drowning man. His human eyes scream to me out of horror of his death. I . . . with him together drown . . . I could

* His school.

not save her. Waters : bitter death : lost." (Stephen meditating by the sea.)

"—I am just taking the names, Hynes said below his breath. What is your Christian name? I'm not sure.

—L, Mr. Bloom said, L for Leopold. And you might put down McCoy's name too. He asked me to.

—Charley, Hynes said writing. I know. He was on the Freeman once. So he was before he got the job in the morgue under Louis Byrne. Good idea a postmortem for doctors. Find out what they imagine they know. He died of a Tuesday. Got the run. Levanted with the cash of a few ads. Charley, you're my darling. That was why he asked me to. O well, does no harm. I saw to that McCoy. Thanks, old chap : much obliged. Leave him under an obligation. Costs nothing." (Bloom at the funeral.)

" Bronze by gold heard the hoof irons, steelyringing

Imperthnthn thnthnthn.

Chips, picking chips off rocky thumbnail, chips.

Horrid ! And gold flushed more.

A husky fifenote blew.

Blew. Blue bloom is on the

Gold pinnaced hair

A jumping rose on satiny breasts of satin, rose of Castille.

Trilling, trilling : Idolores.

Peep ! Who's in the peepofgold ?

Tink called to bronze in pity.

And a call pure long and throbbing. Longindying call.

Decoy. Soft word. But look ! The bright stars fade. O rose.

Notes chirruping answer. Castille. The morn is breaking.

Jingle jingle jaunted jingling.

Coin rang. Clock clacked."

(Opening of 11th episode. Two barmaids watching the Viceregal procession from a publichouse.)

" What did Bloom do ?

He extinguished the candle by a sharp expiration of breath upon its flame, drew two spoonseat deal chairs to the hearthstone, one for Stephen with its back to the area window, the other for himself when necessary, knelt on one knee, composed in the grate a pyre of crosslaid resintipped sticks and various coloured papers and irregular polygons of best Abram coal at twentyone shillings a ton from. Messrs Flower and M'Donald of 14 D'Olier street, kindled it at three projecting points of paper

with one ignited lucifer match, thereby releasing the potential energy contained in the fuel by allowing its carbon and hydrogen elements to enter into free union with the oxygen of the air.

Of what similar apparitions did Stephen think ?

Of others elsewhere in other times who, kneeling on one knee or on two, had kindled fires for him, of Brother Michael in the infirmary of the college of the Society of Jesus at Clongowes Wood, Sallins, in the country of Kildare : of his father, Simon Dedalus, in an unfurnished room of his first residence in Dublin, number thirteen Fitzgibbon street : of his godmother Miss Kate Morkan in the house of her dying sister Miss Julia Morkan at 15 Usher's Island : of his mother Mary, wife of Simon Dedalus, in the kitchen of number twelve North Richmond street on the morning of the feast of Saint Francis-Xavier 1898 : of the dean of studies, Father Butt, in the physics theatre of university College, 16 Stephen's Green, north : of his sister Dilly (Delia) in his father's house in Cabra."

(Soon after the arrival of Stephen and Bloom at Bloom's house).

Of these the most striking is the third. It is a good example of the sort of freak which Mr. Joyce produces from time to time. It is not, however, quite so obscure as it looks away from its context, for some of the things written here reappear during the rest of the episode, in the thoughts of the characters, and many of them are there intelligible. I feel sure that the author's intention, though he has almost completely failed in it, was to prepare the emotions of his readers to accept more readily the scene which follows, in which music and song are made and listened to. Such very meaningless passages are not really common in *Ulysses*; the larger number of its obscurities can be unriddled by reference to other parts of the book, or to earlier works, though this is not always easy. The tendency, however all through the book is to approach this emotion-provoking condition. Where the carousal of medical students is related in a succession of parodies which follow the development of English prose, and are supposed to symbolize the growth of the fœtus in the womb, something is certainly expressed of the collective and half-drunken consciousness of the participators. There is a remarkable novel, called *Parties*, by Mr. Carl van Vechten, in which one feels something very queer in the atmosphere, until the last chapter in which the characters are sober, and one suddenly realizes clearly that they had all been drunk all along. In the episode which follows the carousal, in which Stephen and Bloom and some others visit Dublin's night-town, Mr. Joyce tries, in the form of an insane drama of hallucination,

to express the circumstances under the condition in which they were experienced, as seen by the minds of men drink-crazed. When one understands that this is his object, one sees that he has largely succeeded in giving these alcoholic thoughts and emotions. And in the last section of the book, where, through forty-one unpunctuated pages, he gives the thoughts which pass through the mind of Mrs. Bloom as she slowly falls asleep, there can be no doubt that he has succeeded extraordinarily well in expressing a very difficult psychological state. In *Ulysses* Mr. Joyce has often gone too far, tried to do too much, and failed to achieve the impossible; but he has, I think, reached farther than anyone else in the presentation of the confused mass of thought and emotion which is human consciousness, and especially the most confused states like reverie and intoxication, which are usually presented without their confusion. Other writers leave the confusion to be supplied from their readers' experience of intoxication and sleepiness, and bring the obscure associations of the subconscious into a bright and reasonable light which hardens and clears their outlines, and does not give them in their characteristic state of flux. Mr. Joyce has done these things, and, in spite of the many faults and extravagances in *Ulysses*, he has done what was worth doing—once at least.

It seems quite obvious that there must be a stage at which these efforts and this method will have done all that they can do, and that this limit is reached when what a writer tries to express is no longer expressible in words that are intelligible, unless the untrue clearness and order which language inevitably gives to vague and hidden thoughts and feelings be exaggerated altogether beyond reason. Just where this limit lies is a question of peculiar interest at the present time, when the attempt to express the inexpressible seems to be regarded as an adequate justification of the most chaotic and unintelligible elements in present-day literature. Mr. Joyce (and many another) appears to think that that limit has not been nearly reached yet; while there are some who think that we now are standing "silent upon a peak in Darien" before a great vista of new possibility in literary expression. The vast ocean of the unconscious lies before us, demanding exploration, and deep-browed Joyce is the first who has ruled any of this ever-shifting territory. Certainly, he has done much to shew where the boundary lies.

His latest work is the best of this sort of literature, and if it is a failure, the limit has probably been reached already. Such things as *Anna Livia Plurabel*, *Haveth Childers Everywhere*, and *Two Tales of Shem and Shaun*, are seriously undertaken, and so seriously they have been considered that the first has been translated into French

by a committee with the assistance of the writer himself, who has approved of their result. The following is an extract from it, in original and in translation.

"Don Dom Dombdomb and his wee follyo! Was his help inshored in the Stork and Pelican against bungelars, 'flu, and third party risks? I heard he dug out good tin with his doll when he raped her home, Sabine ashore, in a parakeet's cage by dredgerous lands and devious delts, playing carched and mythed with the gleam of her shadda, past auld min's manse, and maisons Allfou and the rest of incurables and the last of im-murables, the quaggy waag for stumbling."

"Don Dom Dombdomb et elvette sa mie. Est-ce qu'il assura son aide chez Cigogne-Pélican conter Boupilleurs, glippe, et tiers périlleux? Il parait qu'enlevée il la bel et bien fouilla, sa Sabine saumoureuse, dans une cage de perruche boitant par les lyses, faux-filant par deltas, jouant shah que pelotte les reflets de son ombre pres Vils-Viellard et Maisons-Allfou et Issy-le repos et Alta l'oubliette surlaroulant viers lou capilot."

Of *Work in Progress* (the books just named are extracts from this) Mr. Joyce has stated that he is following on *Ulysses*, and is dealing with the night and with dreams where he was dealing with the day and the waking consciousness. How he does this another quotation will illustrate.

"Oh tell me about Anna Livia! I want to hear all about Anna Livia. Well, you know Anna Livia? Yes, of course, we all know Anna Livia. Tell me all. Tell me now. You'll die when you hear Tell me, tell me, how cam she camlin through all her fellows, the neckar she was, the diveline? Linking one and knocking the next, taping a flank and tipping a jutty and palling in and pietaring out and clyding by on her eastway. Waiwhou was the first thurever burst? She says herself she hardly knows whuon the annals her graveler was, a dynast of Leinster, a wolf of the sea, or what he did or how blyth she played or how, when, why, where and who offon he jumnpad her. She was just a young thin pale soft shy slim slip of a thing then, sauntering, by silvamoonlylake, and he was a heavy trudging lurching lieabroad of a Curraghman, making his hay for whose sun to shine on, as tough as the oak-trees (peats be with them!) used to rustle that time down by the dykes of killing Kildare, that forstfellfoss with a plash across her. She thought she's sankh neathe the ground with nymphant shame when he gave her the tigris eye!"

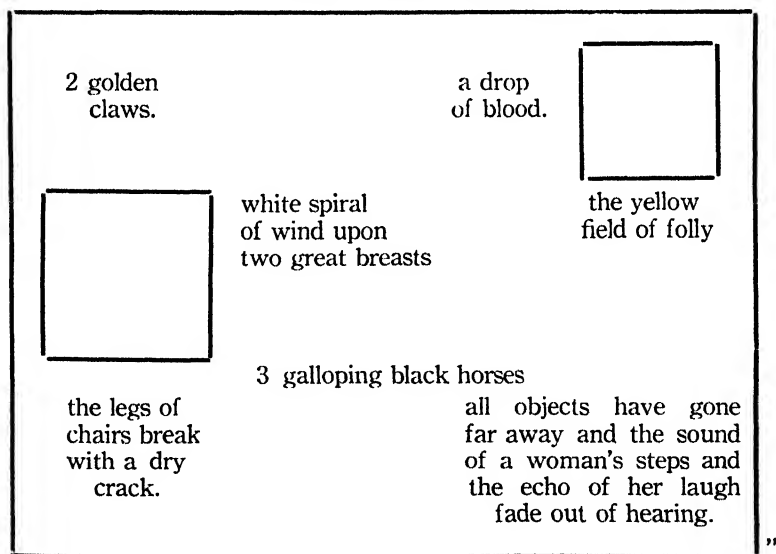
This is worse than *Sordello*. We can discover that Anna Livia is a river (the river Liffey), and we can notice the number of rivers' names that have been slipped into the passage; but who could tell, without first being told, that it describes her rising, flowing into a lake, and forming her first waterfall where a tree fell across her? We can see that *graveller* is meant to suggest grandfather and the gravel in the stream's early bed, and that *silvamoonlyake* is meant to suggest silver, moonlight, a wood (*silva*), and a lake; but who could see in *forstfellfoss*, first, forest, fell, and waterfall, even if they knew the connection between 'foss' and the Scandinavian word for waterfall? But the way he is working is plain to see. He is trying, by concealing what plain meaning he has behind a tissue of rhythm and association, to express a dream-state directly in words. To read these writings while drowsy and falling asleep is to find more meaning in them than is possible at any other time; but it is very little. There is certainly some beauty of rhythm and verbal music in this, as in many other passages of *Work in Progress*, and no doubt the mind does, half-consciously or sub-consciously, take up some of the mass of suggestion and derive emotional pleasure and even profit from it. But all it does is vaguely to suggest what it is intended to express, and to do so in a way thoroughly disproportionate to the amount of labour that is put into it by the writer or required of the reader. It is said that to hear Mr. Joyce himself reading this work is a great experience, and can change a superficial dislike into admiration; but a good delivery often makes much greater nonsense than this palatable, temporarily. If, as is implied in the view that this is the right course for the development of literature, the aim is to produce emotion directly, without either giving information or provoking intellectual effort, without affecting either the thought-content or thought-form of the reader's mind, in short if literature is to occupy the province of music, then by far the greater part of esteemed literature is unworthy.

Mrs. Q. D. Leavis, a devotee of the Cambridge school of criticism in a note to her *Fiction and the Reading Public*, names a small group who are for her, and presumably for her school, all that is good among writers of English to-day. They are Messrs. Joyce, Eliot, T. F. Powys and Forster, and Mrs. Virginia Woolf, all of whom are chiefly concerned with suggestion, some of whom appear to be concerned with little else, and who are, to various degrees, unintelligible. This, or something like it, seems to be the opinion of a large number of the most able of the younger writers and thinkers on literature to-day. It is no doubt variously due to the influence of Joyce, to the growth of the psychology of the sub-conscious, to anthropological investigations of the literature of savages, and to the

Communist ideal of literature as propaganda. But Dr. Richards' discovery that emotional associations and suggestions play a much larger part in the use of words than was previously thought hardly seems a sufficient reason for relegating meaning, in its ordinary sense, to a back seat, and making all-important the emotional suggestion alone.

The *Quarterly* called Keats unintelligible, rugged, diffuse, tiresome, and absurd. There is always the danger that in objecting to anything new we may misjudge similar greatness, but the obscurity of modern poets is not the same thing as the unintelligibility of Keats. Recently I read through the complete issues of *New Verse* again. This appears every two months, contains reviews and poems, and is the organ of a most advanced school of English poetry. To me, the majority of these poems are not intelligible. Here are two examples.

"Poem in Seven Spaces."



"Gnu Opaque.

No more resistance
 No letters this morning
 To-morrow will be a fine day
 Screeds of such blossomings
 Should fill each lenten interval

* This poem may not be fairly quoted, as, in the original, its perimeter is a square and not an oblong. It is said to be a translation.

Lobster-clawed love should diminish
 On the roads leading to all countries
 Famine veers away
 They said maritime provinces
 N or M
 It isn't easy to see in this light
 And night writes no replies."

This is not like the obscurity of Shelley or Wordsworth, or even of Blake. There does not seem to be anything to take hold of so that something may be felt, although the meaning cannot be seen.

But there is no doubt that these writers are serious, nor that there is great ability among them. Why then this sort of thing? There are two reasons: the Joycean endeavour to express in words incoherent and subconscious attributes of mind, mental states which neither take form in words nor are coterminous with words; and the wish, conscious or not, to please only those who are willing to devote great labour to the reading. Mr. T. S. Eliot's *Waste Land* is designed only for the pleasure of those who have the learning, the ingenuity, and the time to follow his allusions and symbols. As some insects simulate the look of others whose flavour is unpleasant, so recent poets seem to assume a dress that is attractive only to the inquisitive, the fashionable, and the partisan. This is not unnatural, when so much second-rate passes as good because it gives the half-educated mass the feeling of being interested in art, culture, and thought. It is a phase, likely to pass. But will the attempt to put emotions in words, without any intermediary process of intellect, die or continue? It looks as if these people were determined that it shall continue, and that future emotional literature shall be either a new form of poetry, by the best writers, acting directly, or the old way carried on by the worse, playing intelligibly on the commonplace and unsubtle feelings of the British bourgeoisie. The explanation of all this lies in Dr. Richards' "stock responses" to words and phrases, which go far to explain the emotional effect of much that is not æsthetically good; but which do not, as the left wing seems to think, mean that all stock responses are bad and to be avoided. Often they intensify and enlarge the meaning of words in a most valuable way. Not the attempt to sterilize words of intellectual meaning and current emotional implication is needed, but, as ever, discretion in the choice of words—

*multa renascentur quae iam cecidere, cadentque
 quae nunc sunt in honore vocabula, si volet usus
 quem penes arbitrium est et ius et norma loquendi.*

J. O. BARTLEY.

CHRISTOPHER MARLOWE :

“ Next Marlowe bathed in the Thespian springs
Had in him those brave translunary things
That the first poets had ; his raptures were
All air and fire which made his verses clear ;
For that fair madness still he did retain
Which rightly should possess a poet's brain.”

MICHAEL DRAYTON.

By the side of this contemporary estimate, all subsequent criticism of Marlowe seems either tame or irrelevant. Drayton had realised that Marlowe was above everything else a poet. Marlowe indeed had bathed his imagination in the riot and tumult of life and when he turned his visions into verse they glowed with a vital and luxuriant charm. They surprised and delighted rather than mystified their audience. Three centuries and more have passed since Elizabethan actors declaimed Marlowe's mighty periods before crowded audiences, sending them home enraptured and satisfied at once. Other Titans have followed claiming the adulation of the English—a Shakespeare, a Milton, a Pope, a Byron, a Bernard Shaw. But Marlowe is in no danger still of being forgotten entire. He will always have his admiring readers who capture in his verse the thrill, the exact cast of which is nowhere else to be sought ; he will be the *enfant terrible* of the Elizabethans, dear and most dear to the youth of all times ; he will be to all true students of English literature, great as he is already, among the very greatest of “ the inheritors of unfulfilled renown.”

Little is known of Marlowe's life, and what little is given by his biographers is largely the result of conjecture. He was born probably in 1564, the son of a Canterbury shoemaker ; he was educated at the Canterbury King's School, and later at the Benet's (or as it is now called, Corpus Christi) College, Cambridge. He took his B. A. degree in 1583 and the M. A. degree in 1587. Marlowe's life after he left Cambridge is more or less a blank. It is possible he took service in the army for a brief period, for his writings reveal a peculiar intimacy with military affairs ; in any case, he has given us a truly remarkable account of his mental life in the dramas he wrote in quick succession and that soon took London by storm. The usually accepted chronology of the plays is as follows: *Tamburlaine* Part I

(1587), *Tamburlaine* Part II (1588), *The Tragical History of Dr Faustus* (1589), *The Jew of Malta* (1590), *Edward The Second* (1592), and *The Massacre at Paris* (1593). Besides, there is the play *Dido, Queen of Carthage*, published in 1594 and attributed on the title-page to Marlowe and Nash; the unfinished poem "Hero and Leander" which was later ineptly completed by the pedantic Chapman; and Marlowe's translations of Ovid's "Elegies" and the first book of Lucan. It may also be mentioned that the late Mr J. M. Robertson has found evidence of Marlowe's hand in several of Shakespeare's plays, "Henry VI", Parts I, II, & III, "Richard III", "Henry V", "Julius Caesar", and "Comedy of Errors." He quotes the opening lines in the Prologue to *Dr Faustus*--

"Not marching now in fields of Thrasimene,
Where Mars did mate the Carthaginians;
Nor sporting in the dalliance of love,
In courts of kings where state is overturn'd;
Nor in the pomp of audacious deeds, . . ."

and finds in them references to three of Marlowe's early plays. The first of these should have been a Carthaginian play, probably named "Hannibal", now lost; the second should refer to *Edward II*; and the third to *Tamburlaine*. According to this view, *Edward II* is an "early" play rather than the last and best play that Marlowe wrote. As yet, however, Mr Robertson's thesis has not been generally accepted.

Marlowe, like some of his brother "University Wits", notably like Greene and Kyd, seems to have had an evil reputation in his own day. At this distance of time it is impossible to winnow out the fact from the dross of foggy rumour and legend it is mixed up with. His plays show well enough how daring and reckless Marlowe's personality should have been; it is almost certain he felt emancipated in soul and recognised no power above him for good or bad; he should have been an atheist in the first flush of his dawning manhood, willing to set no limits to his feelings, thoughts and actions. But such specific charges as have been laid at his door, in his life-time or afterwards, can be dismissed, for the present, as unproven. Neither Greene's dying accusations nor the vicious allegations by the notorious Baines (who was justly hanged some months hence) are corroborated by other impartial evidence. It is however true Marlowe met his death violently at Deptford on June 1st 1594. Marlowe had been living at Deptford for some time when the Plague was raging in London. He had picked up a quarrel at the village tavern with Charles Archer, a serving man, and probably the quarrel referred to a woman of loose

character. Marlowe raised his knife against Archer, who in self-defence turned it against the poet and so fatally wounded him. On the other hand, Marlowe seems to have been rather popular with some of his august contemporaries, people like Shakespeare, Nash Chapman and Sir Walter Raleigh.

It is fruitless and uninspiring to ransack Elizabethan documents and other remains with a view to get a glimpse of the real man that Marlowe was. It is more profitable to spend one's time with the rich legacy of poetry he has left posterity, hoping to see in it an image of the man's unbridled genius, his ambitions, his triumphs, his defeats. Marlowe is in all his heroes, in a spiritual and fundamental sense: he is Tamburlaine, he is Faustus, he is Young Mortimer, he is Barabas even. No writer can project a soul into literature that is not in the last analysis his own; it is only in that sense we can equate Shakespeare with Hamlet, with Macbeth, with King Lear, with everyone of his great creations. So too Marlowe's heroes, when they are filled with the frenzy of their whole existences and scream out their hopes and fears in terms of poetry, reduce themselves to his own sole self.

To his first hero, Tamburlaine, Marlowe devoted two complete plays. The title-pages of the first printed editions of the plays give interesting details: "Tamburlaine the Great, who from a Scythian shepherd, by his rare and wonderful conquests, became a most puissant and mighty monarch, and, for his tyranny and terror in war, was termed the Scourge of God"; "Tamburlaine the Great, with his impassionate fury for the death of his Lady and Love, fair Zenocrate, his form of exhortation and discipline to his three sons, and the manner of his own death." It is distantly reminiscent of Preston's crude play, "Cambyzes"; and if *Tamburlaine* is so immeasurably in advance of these earlier attempts, what makes the difference is Marlowe's imagination and the irresistible power of his verse. Tamburlaine is nearly always upon the stage and is nearly always talking: and when he speaks, we seem to dissolve in the flood-tide of his noble eloquence. Very early in the play he assures the captive maiden, Zenocrate, the Soldan's daughter, whom he was later to make his Queen:

"I am a lord, for so my deeds shall prove:
And yet a shepherd by my parentage.
But, lady, this fair face and heavenly hue
Must grace his bed that conquers Asia,
And means to be a terror to the world,
Measuring the limits of his empery
By east and west, as Phœbus doth his course."

To all Marlowe's characters figurative language is second nature. Thus Thermidamas, on meeting Tamburlaine for the first time, breaks out :

“ Tamburlaine !—

A Scythian shepherd so embellished
With nature's pride and richest furniture !
His looks do menace Heaven and dare the gods :
His fiery eyes are fix'd upon the earth,
As if he now devis'd some strategem
Or meant to pierce Avernus' darksome vaults
To pull the triple-headed god from hell.”

And another Persian Lord describes Tamburlaine thus :

“ Of stature tall, and straightly fashioned,
Like his desire, lift upwards and divine ;
So large of limbs, his joints so strongly knit,
Such breadth of shoulders as might mainly bear
Old Atlas' burden ;”

The career of Tamburlaine had no doubt caught Marlowe's imagination. The histories Marlowe had had access to spoke of Tamburlaine's incredible procession of conquests, spoils, and tyrannies ; and these had simply to be cut up into scenes and lit up with the fiery incandescence of verse. Tamburlaine becomes King of Persia ; he marries Zenocrate the Princess of Egypt ; he becomes the Emperor of the Turks and puts the ex-Emperor Bajazeth into a cage, where he is fed on the remains of Tamburlaine's table by the ex-Empress, Zabina ; he has his chariot drawn by deposed kings ; he kills his eldest son, unable to bear the thought he is not forward and fierce enough ; he burns a city to the ground on the death of Zenocrate ; he is vaulting ambition incarnate, the Renascent ideal of individual liberty and aspiration pushed to a point, when it is so awful it turns into a caricature.

As Professor Legouis reminds us, “ It was never necessary to parody *Tamburlaine*.” Perhaps there was a streak of parody somewhere in the fabric of Marlowe's genius ; it is not so very unlikely after all that Marlowe had intended his plays to be parodies or caricatures in the core of their constitution. But conscious parody or otherwise, Tamburlaine's actions and sentiments are indisputably awful or absurd and only the magic of the utterance could have lulled the audiences (as it lulls us even to-day) into a pleasurable acquiescence. Who stops to consider the intellectual content of lines like :

“ Our quivering lances, shaking in the air,
And bullets, like Jove's dreadful thunderbolts,

- Enroll'd in flames and fiery smouldering mists,
 Shall threat the Gods more than Cyclopan wars”
- “What better precedent than mighty Jove?
 Nature that fram'd us of four elements,
 Warring within our breasts for regiment,
 Doth teach us all to have aspiring minds:
 Our souls, whose faculties can comprehend
 The wondrous architecture of the world,
 Wills us to wear ourselves, and never rest,
 Until we reach the ripest fruit of all,
 That perfect bliss and sole felicity,
 The sweet fruition of an earthly crown.”
- “The cherubins and holy seraphins,
 That sing and play before the King of kings,
 Use all their voices and their instruments
 To entertain divine Zenocrate.”
- “In vain, I see, men worship Mahomet.
 My sword hath sent millions of Turks to Hell,
 Slew all his priests, his kinsmen, and his friends,
 And yet I live untouched by Mahomet.
 There is a God, full of revenging wrath,
 From whom the thunder and the lightning breaks,
 Whose scourge I am, and him will I obey”

They are, if you will, arrant bombast, and they are also memorable poetry. So great is the enchantment of this poetry that we are able to stomach all Tamburlaine's affectations and atrocities, all Bajazeth's curses and credulities, and all the curiously divers concomitants of this history. In this Marlovian land of awe and wonder there is indeed a place for even a man like Tamburlaine; with him might is right and in this fantastic land we are deluded into thinking that it all should be right; and his earthly course run through, as Tamburlaine dies declaiming for the last time —

- “Farewell, my boys; my dearest friends farewell!
 My body feels, my soul doth weep to see,
 Your sweet desires depriv'd my company,
 For Tamburlaine, the scourge of God, must die”,

we cannot help forging in his life, for a dazzled moment at any rate, a rounded completeness that makes the career of any other military hero tame in comparison.

For his next play, *Dr. Faustus*, Marlowe raided mediæval legend, as he had raided Pedro Mexia and Perondinus for the two Parts of *Tamburlaine*. The Faustus of legend was a man in quest of pleasures while the nineteenth century Faust of Goethe's was

a man in quest of knowledge: but Marlowe's Dr. Faustus was in quest of power more than anything else. *Dr. Faustus* is even more starkly a one-man play than *Tamburlaine*. In his very first speech he tells us what is in his mind:

"These metaphysics of magicians
And necromantic books are heavenly;
Lines, circles, scenes, letters, and characters,
Ay, these are those that Faustus most desires.
O what a world of profit and delight,
Of power, of honour, of omnipotence
Is promised to the studious artisan!
All things that move between the quiet poles
Shall be at my command."

Faustus has presently warnings and encouragements respectively from the Good Angel and the Bad Angel. But he is possessed by the idea, and its possibilities throw him into an ecstasy:

"Shall I make spirits fetch me what I please,
Resolve me of all ambiguities,
Perform what desperate enterprise I will?
I'll have them fly to India for gold,
Ransack the ocean for orient pearl,
And search all corners of the new-found world
For pleasant fruits and princely delicacies . . ."

Faustus's mind is made up; he conjures up Mephistophilis who, in a chance poignant moment, goes out of the way to advise Faustus:

" . . . leave these frivolous demands,
Which strike a terror to my fainting soul."

But it is no use; Faustus would out-Mephistophilis Mephistophilis by advising him to learn manly fortitude "and scorn those joys thou never shalt possess." In due course a deed of agreement is signed between Lucifer, Prince of Hell, and John Faustus of Wittenberg. Faustus is to have all his desires for twenty-four years after which he is to be, body and soul, Lucifer's property. During this long period Faustus has oases of repentance followed by dismal tracts of dissipation and arid fulfilment. He is taken round the world; he holds interminable discussions with Mephistophilis; he plays practical jokes on the Pope, the German Emperor, and other high functionaries; he summons the ghosts of Alexander and Helen, to the latter of whom he addresses the immortal lines—

"Was this the face that launch'd a thousand ships,
And burnt the topless towers of Ilium?
Sweet Helen, make me immortal with a kiss.

Her lips suck forth my soul ; see where it flies !—
 Come, Helen, come, give me my soul again.
 Here will I dwell, for Heaven be in these lips,
 And all is dross that is not Helena . . . ”

The ministering good angel, the Old Man, his own disturbing soul, all try to save him from the imminent annihilation. But Mephistophilis has only to appear again, and weaker, ever weaker grow Faustus's lines of defence, more abject his entreaties to be pardoned, more vehement his promises to speak of none and think of none but the Devil and hell. At last the twenty-four years are very nearly over ; one solitary hour remains, and Faustus is alone in his room, and Marlowe writes the greatest scene he ever did. Faustus's piercing cry verily palpitates on the brink of the unwordable and the “ mighty line ” seems suffused with a potential of irresistible suggestion :

“ Ah, Faustus,
 Now hast thou but one bare hour to live,
 And then you must be damn'd perpetually !
 Stand still, you ever-moving spheres of Heaven,
 That time may cease, and mid-night never come ;
 The stars move still, time runs, the clock will strike,
 The Devil will come, and Faustus must be damn'd.
 O, I'll keep up to my God ! Who pulls me down ? . . .
 Let Faustus live in hell a thousand years—
 A hundred-thousand, and at last be sav'd !
 O, no end is limited to damned souls ?
 Why wert thou not a creature wanting soul ?
 Or why is this immortal that thou hast ? . . .
 O soul, be chang'd into little water-drops,
 And fall into the ocean—ne'er to be found.
 My God ! my God ! look not so fierce upon me !

(Enter Devils)

Adders and serpents, let me breathe awhile !
 Ugly Hell, gape not ! come not, Lucifer !
 I'll burn my books !—Ah Mephistophilis ! ”

There is surely no such denouement in all literature. It is undeniably one of the summits of English dramatic poetry. In *Dr. Faustus* Marlowe attempted a new type of the old morality play and succeeded in vivifying it into authentic drama. Spirits and devils, symmetrical characters like the Good Angel and the Bad Angel and the Seven Deadly Sins, do not detract from the play its essentially human interest. Dr. Faustus, the medical man, and John Faustus, in league with the Devil, have a close resemblance with the more

modern, nineteenth century concoction of Stevenson's, the celebrated Dr. Jekyll and Mr. Hyde. Wagner, the devoted servant to Dr. Faustus, has also his counterpart in the unexceptionable Poole. The Faustus theme is bound to come up in literature again and again in a thousand differentiations and Marlowe is destined to inspire it every time.

The Jew of Malta is the "thriller" among Marlowe's tragedies. It opens characteristically with a Prologue spoken by the Ghost of Machiavelli where occur the challenging lines :

"I count Religion but a childish Toy,
And hold there is no sin but Ignorance."

The first scene reveals Barabas, the rich Jew of Malta, in his counting-house ; he is poetically moved by the sight of his gold and he speaks as John Gabriel Borkman speaks in Ibsen's play. He learns that his ships have come back heavily laden with riches : he is thankful—

"What more may Heaven do for earthly man
Than thus to pour out plenty in their laps,
Ripping the bowels of the earth for them,
Making the Sea their Servant, and the winds
To drive their substance with successful blasts?"

Now he receives summons to appear before the Governor. There he is told that half his fortune is forfeit as tribute to the Turks. He demurs and the Governor clinches the issue by decreeing that the Jew's entire property is forfeit. Barabas admirably controls his passion and his speech is dignified :

"Well then my Lord, say, are you satisfied ?
You have my goods, my money, and my wealth,
My ships, my store, and all that I enjoy'd ;
And having all, you can request no more ;
Unless your unrelenting flinty hearts
Suppress all pity in your stony breasts,
And now shall move you to bereave my life."

Barabas's house is turned into a nunnery. In order to recover some considerable sum of money, jewels and precious stones he had securely hidden in his house, Barabas persuades his daughter, Abigail, to get into the house as a nun for the night and hand over to him the riches. This accomplished, she returns to her father's house.

From now on Barabas lives only to be revenged on the Governor particularly and on Christians generally. Barabas should have his confidante and slave and luckily for him he meets Ithamore. Their first meeting is significant. Barabas advises his slave :

“ First be thou void of these affections,
Compassion, love, vain hope, and heartless fear,
Be moved at nothing, see thou pity none.
But to thyself smile when Christians moan.”

Ithamore answers simply : “ Oh brave master, I worship your nose for this.” Barabas gives an account of his hobbies in life :

“ . . . I walk abroad a nights
And kill sick people groaning under walls :
Sometime I go about and poison wells. . . ”

Now it is Ithamore's turn to regale the audience : he too has hobbies.

“ Setting Christian villages on fire,
Chaining of Eunuchs, binding galley-slaves.
One time I was an Hostler in an Inn,
And in the night time secretly would I steal
To travellers Chambers, and there cut their throats...”

Barabas is delighted and strikes a bargain :

“ Why this is something : make account of me
As of thy fellow : we are villains both :
Both circumcized, we hate Christians both. . . ”

Crimes follow one after the other. Barabas causes misunderstandings between the Governor's son and another, both Christians and in love with Abigail, and they kill each other ; Abigail repents her unwitting part in the affair and now seriously becomes a nun ; Barabas is enraged and contrives to poison all the nuns, who die immediately, but not before Abigail has confessed everything to a friar ; this blundering friar, with a companion, goes to Barabas with a view to converting him to Christianity but he manages to kill one and make the other die at the executioner's hand ; meanwhile Ithamore, under the influence of wine and woman, tries to blackmail Barabas, who with poisoned flowers kills the slave, his mistress and her bawd ; Barabas is suspected and is jailed, but he feigns death and is thrown outside the gates of the city ; he joins forces with the Turks and delivers Malta into their hands ; immediately he bargains with the captive Governor and plans an elaborate finish to his career of crime by arranging for the explosion of all the Turkish soldiers and the death of the Turkish general in a burning cauldron ; however, in this last thing he is foiled, the Governor preferring to throw Barabas into the cauldron and rather trusting to the Turkish general's sense of equity and justice. Even at this extremity, Barabas is at bay, not vanquished in spirit :

“ Then Barabas breathe forth thy latest,
And in the fury of thy torments, strive

To end thy life with resolution...
 And had I but escaped this strategem,
 I would have brought confusion on you all
 Damn'd Christians, dogs, and Turkish Infidels ;
 But now begins the extremity of heat
 To pinch me with intolerable pangs :
 Die life, fly soul, tongue curse thy fill and die."

There is something strangely attractive in the triumphant final assertion of this maniac. Much as the last three acts distort and destroy the rich promises of the first two, the play as a whole is unmistakably the work of Marlowe. And the Barabas of the first two acts, with his love of money, his attachment to his religion, his intense selfishness and withal noble restraint when pitted against the hypocrisy and callous injustice of the Christian Governor, is surely the most truthful and sympathetic portrait of the Jew in Elizabethan literature. Barabas's penumbra in crime, Ithamore, is a first sketch of the Iagos and Bosolas to come. That he should be infatuated by the courtesan and sing to her verses like

" I'll be thy Jason, thou my golden Fleece ;
 Where painted Carpets o' er the meadow are hurl'd
 And Bacchus vineyards o'erspread the world..."

is one of the minor surprises in this grim tragedy.

Several of Marlowe's critics have been puzzled by his *Edward II*. We have already referred to Mr. Robertson's views regarding its position in the chronology of Marlowe's plays. He draws our attention to the numerous instances of *stichomythia* in *Edward II*, and as this was an archaic element in Elizabethan drama, concludes that the play had been written much earlier than is generally supposed to be. That its verse is more pliable and is a nearer approximation to human voice than the verse of *Tamburlaine* and *Dr. Faustus*, may merely be due to the difference in the very subject matter and also to the different mode of composition. Mr. Robertson further lays stress on the superior power of Faustus's death-scene when compared with *Edward II*'s ; but this by itself cannot prove the earlier composition of *Edward II*. Perhaps, Mr. Robertson's view that the present version of *Edward II* was not the original one is the most satisfactory way out of the difficulty. It is quite probable that some changes were made by the author for the production of 1590 and some other changes for the publication of the play in 1594. However, one criticism seems to be valid against Mr. Robertson's approaches to Elizabethan drama ; he is ever more concerned with the poetical rather than the dramatic quality of a play and he cannot give due credit to the advance in dramatic technique that *Edward II*

signifies in Marlowe's career. All this is implicit in Mr. Robertson's otherwise extremely discriminating judgment ; " Marlowe is first and last a literary and artistic personality . . . He is the embodiment of the forward leaping muse of aspiration ' still climbing after knowledge infinite ', conceiving something more ideal than drama, the philosophical dramatic poem, which cannot be realised without making drama miss its compulsory mark. "

To return to *Edward II*; as a historical play, it is mid-way between the crudities of early plays like Bale's " King Jehan " and the rounded perfections of Shakespeare's " Henry IV " and " Henry V. " The play opens with the recall of Edward II's favourite, Gaveston. The nobles are enraged and demand his banishment. The Queen, Isabella, is distraught with grief and tells the intrepid young nobleman Mortimer :

" . . . now my lord the king regards me not,
But dotes upon the love of Gaveston.
He clasps his cheeks, and hangs about his neck,
Smiles in his face, and whispers in his ears ;
And when I come he frowns, as who should say,
' Go whither thou wilt, seeing I have Gaveston. ' "

Gaveston is banished by the nobles in council but is again recalled and a truce is patched up between the king and his barons. The truce, however, is short-lived ; a civil war breaks out, the king is arrested, Gaveston is murdered, and supreme power passes virtually to the hands of the Young Mortimer. Meanwhile the Earl of Kent, Edward's brother, beginning as a staunch supporter and then a rebel, now veers back to loyalty to his brother and king. He suspects Mortimer and Isabella of illicit love, but for the present he could do nothing. Already Mortimer and Isabella are entrenched in power and Prince Edward nourishes his own boyish fears of the all-highest Mortimer. Edward II's tortures begin ; he is compelled to give away his crown ; he is moved from place to place as pledge against attempts to release him ; he is kept in a water-filled dungeon, perpetually frightened by the drum outside, and the unhappy king's outburst is pathetic to a degree :

" But can my air of life continue long
When all my senses are annoy'd with stench ?
Within a dungeon England's king is kept,
Where I am starv'd for want of sustenance.
My daily diet is heart-breaking sobs,
That almost rends the closet of my heart . . .
The wren may strive against the lion's strength,

But all in vain : so vainly do I strive
 To seek for mercy at a tyrant's hand. "

Edward is washed by puddle water and his beard is shaved away ; and Kent, who comes to rescue him, is charged with treason and executed, so much so Prince Edward, now Edward III, exclaims :

" What safety may I look for at his (Mortimer's) hands,
 If that my uncle shall be murdered thus ? "

Mortimer decides that Edward II should die ; he sends an ambiguous letter that is nothing less than the death warrant. On seeing Lightborn, who has brought the letter to the King's warders, Edward speaks out :

" My mind's distemper'd, and my body's numb'd,
 And whether I've limbs or no, I know not.
 O, would my blood drop out from every vein,
 As doth this water from my tatter'd robes.
 Tell Isabel, the queen, I look'd not thus,
 When for her sake I ran at tilt in France
 And there unhors'd the Duke of Clermont . . .
 Something still buzzeth in mine ears,
 And tells me if I sleep I never wake . . . "

And then he is done to death under a table ; and the murderers poniard Lightborn, lest he spit out the truth ; and Edward III is enraged, and assuming full power, sends his mother to the Tower and Mortimer to his instant execution ; and Mortimer departs, his head bloody but unbowed, flinging out the words :

" Base Fortune, now I see, that in thy wheel
 There is a point, to which when men aspire,
 They tumble head-long down ; that point I touch'd,
 And, seeing there was no place to mount up higher,
 Why should I grieve at my declining fall ?
 Farewell, fair Queen ; weep not for Mortimer,
 That scorns the world, and, as a traveller,
 Goes to discover countries as yet unknown. "

From the foregoing it must be clear that in Young Mortimer alone is present the significantly Marlovian lust for ambition and power, in other words the peculiar Machiavellian *virtu*. Mortimer is strong of will, uncomplaining, and unscrupulous ; and he is all that make a Tamburlaine minus his never-failing success or a Faustus minus the halo of his magic. Edward II himself is weak, ineffectual, sentimental, and often childish. His fatal attraction to Gaveston is explainable only on the basis of homosexual love ; nor do passages like the following in the play permit of any other interpretation :

" The mightiest kings have had their minions ;
 Great Alexander loved Hephestion ;
 The conquering Hercules for Hylas wept ;
 And for Patroclus stern Achilles droopt ;
 And not kings only, but the wisest men ;
 The Roman Tully lov'd Octavius ;
 Grave Socrates, wild Alcibiades . . . "
 " Sometime a lovely boy in Dian's shape,
 With hair that gild the water as it glides,
 Crownets of pearl about his naked arms,
 And in his sportful hands an olive tree,
 To hide those parts which men delight to see,
 Shall bathe him in a spring . . . "

Gaveston, on the other hand, has dash, cunning and any amount of daring. He is devoted to the King and sincerely loves his niece. As for Isabel, she is not convincing at all ; she is either a mere fool and dotard or the most terrible of tigresses. Did she love Edward any time ? As between her and Mortimer, is not the love all on one side, hers being infatuation and his all devouring ambition ? Prince Edward as child, as boy King, as firm adolescent avenger of his father's death, is credible everywhere. The Earl of Kent is a curious character ; he is fatally afflicted with the malady of indecision. He is disgruntled every time and everywhere. He is ever complaining, ever incurring somebody's odium, ever too slow to influence the action, and ever unpleasantly troubled in his conscience. Gurney, the murderer, is like Bosola in Webster's play, an artist in torturing ; he is a low villain evolved out of darkness.

Certainly *Edward II* does not degrade the great name of Marlowe. It is a better play than any other that Marlowe wrote. It is also possible to discover in its plot the germs of the Marlovian ethics. Is its central theme no more than the advocacy of moderation in all things ? Gaveston, though recalled, need not have been made Lord Chamberlain and all that ; Mortimer, though Lord Protector, need not have ordered the execution of Edward and Kent ; an excess of anything is evil and returns against itself and, cancelling it out, brings about an ultimate normality. An obsession of unnatural or natural love ; an obsession for power or for lust ; they are both abnormalities, and life rids itself of these and re-establishes its norm. The verse of *Edward II* is like its action, restrained and rapid by turns and not seldom mighty and swelling. End-stopped lines are the rule and there are any number of instances of double-endings, coming in little dumps. Perhaps Mr. Havelock Ellis is right in his opinion that " in none of the other plays have all of Marlowe's powers combined so happily to one great end. "

Marlowe's two remaining plays need not detain us long. *The Massacre at Paris* is a play in three acts dealing with the stirring events in France between 1572-89. Catherine de Medici, Regent in the place of the minor Charles IX, is in league with the Duke of Guise, leader of the Catholic party and inwardly scheming to get the throne for himself. Guise speaks as if he were an earlier edition of Shakespeare's Richard III :

"Set me to scale the high Pyramids,
And thereon set the diadem of France,
I'll either rend it with my nails to naught,
Or mount the top with my aspiring wings,
Although my downfall be the deepest hell."

The first act takes us through the horrors of the St. Bartholomew Massacre on the night of August 24th, 1572. Guise flits across the stage as a low butcher. Huguenots are very nearly exterminated. Guise's power steadily increases till, on Charles IX's sudden death, the formerly atrocious Duke of Anjou become king as Henry III, and pits his strength against the Dictator. Guise has another rebuff, this time from his wife ; he surprises her in the act of writing a love letter to her paramour Mugeroun and asks her :

"Am I grown old, or is thy lust grown young,
Or has my love been so obscured in thee,
That others needs to comment on my text?"

Guise is powerless to stem the rising tide of animosity against his rule. The new king has Guise stabbed by hired peasants and he dies praying that his brothers would avenge his death. Guise's youngest brother, Duke Dumaine, answers this prayer presumably, for very soon King Henry III is murdered too and Henry of Navarre, husband to Margaret, Catherine's daughter, becomes king of France as Henry IV.

Few characters in this play are convincing. Guise is too stark a butcher, Catherine is too inhuman a female, Navarre too colourless, Charles IX too incredibly effeminate and weak-willed, and Henry III too contradictory a character, that one cannot praise the play for its characterisation ; neither can one compliment it on its construction. Its real beauty is in the splendour of isolated speeches where the authentic Marlovian thunder holds us spell-bound. The play should also have delighted the largely protestant audiences of Elizabethan England. And speeches like the following should certainly have fired the enthusiasms of the English with their extravagant worship of their Virgin Queen :

"These bloody hands shall tear his triple crown,
And fire accursed Rome about his ears.

I'll fire his crazed buildings and enforce
 The Papal towers to kiss the holy earth.
 Navarre, give me thy hand, I here do swear
 To ruinate that wicked Church of Rome,
 That hatched up such bloody practices,
 And here protest eternal love to thee,
 And to the Queen of England specially,
 Whom God hath blessed for hating Popistry . . .
 Fire Paris where these treacherous rebels lurk.
 I die Navarre, come bear me to my sepulchre.
 Salute the Queen of England in my name,
 And tell her Henry dies her faithful friend."

It is also possible that the present version of the play is merely a theatrical abridgment, bearing marks of corruption and vulgarisation on every page which Marlowe did not live to erase finally.

The last of the plays to be discussed here is *Dido Queen of Carthage*. The extent of Nash's authorship of this play has proved a vexed question these three centuries. Did Nash merely revise the play? Or did he complete an unfinished play by furnishing the last scenes or acts? On the whole, the former seems to be the more reasonable view to take. The distinctive touches of "the alchemist of eloquence", Marlowe, are scattered over the entire play, and probably, Nash did nothing more than generally revising the play, adding some lines in Æneas's long speech recounting the Trojan War, and seeing the play through the press. Dido is the only great woman character in Marlowe's plays; but she is enough to still the parrotting cry that he could not gloriously vivify a woman in drama. Mr Boas rightly remarks: "Dido, the oriental queen, is conceived with power and refinement, but instead of being a complex creation like Shakespeare's Cleopatra, she is yet another of Marlowe's embodiments of limitless desire, which in her case takes the form of amorous passion." Marlowe's play is faithful to the Virgilian original, several lines from the "Æneid" actually appearing in translation. Æneas, sole survivor of the mighty Trojan warriors, after a long voyage, lands in Carthage and introduces himself to us in these terms:

"Of Troy am I, Æneas is my name,
 Who driven by war from forth my native world,
 Put sails to sea to seek out Italy
 But hapless I, God wot, poor and unknown,
 Do trace these Lybian deserts all despised,
 Exiled from Europe and wide Asia both,
 And have not any coverture but heaven."

His mother Venus puts courage into him and now as ever would

scheme for his preferment. Æneas and his son are received by Dido, the queen of Carthage, and treated royally. Venus sends Cupid to Carthage disguised as Æneas's boy; Dido innocently takes him in her arms and instantly Cupid touches

" . . . her white breast with this arrow head,
That she may dote upon Æneas' love."

Dido is hopelessly in love with Æneas. But her superb maidenly modesty restrains her from revealing her secret to her lover. She plays a sort of pathetic blind-man's-bluff with Æneas. She would repair all his Trojan ships, give him tackling made of richest gold, barks of odoriferous trees, oars of massive ivory full of holes, and anchors hewed from crystal rocks; but Æneas himself should stay in Carthage with Dido, crystal his friend Achates with the ships to Italy. Æneas could scarce fail to understand her meaning. But no, he is not to suppose that Dido is in love with Æneas, for she says:

" . . if that any man could conquer me,
I had been wedded ere Æneas came:
See where the pictures of my suitors hang,
And are not these fair as fair may be?"

It is sweetly pathetic to watch her essentially feminine juggling with her emotions, words and actions. They are driven into a cave during a storm and there suddenly she confesses her love. Æneas on his part swears eternal love for Dido and their days pass in a delirium of happiness. Hermes soon appears to Æneas in a dream and reminds him of his appointed voyage to Italy. He decides to leave Carthage immediately; but Dido appears on the scene at the nick of time, demanding "Is this thy love to me?" He wavers this time and, as she asks him to wear the imperial crown of Lybia, re-affirms his original vow:

" O Dido, patroness of all our lives,
When I leave thee, death be my punishment.
Swell raging seas, frown wayward destinies,
Blow winds, threaten ye Rocks and sandy shelves,
This is the harbour that Æneas seeks,
Let's see what tempests can annoy me now."

From now on Dido's one constant obsession is that Æneas may leave her for ever. She takes precautions: she sends away his son to be brought up in secret by her nurse; she takes away the tackling, oars and sails; she even thinks of sinking his ships. Æneas himself for the nonce plans to build a new city in Carthage, statelier far than Troy. But Hermes intervenes again and chides him for forgetting

Italy. Æneas receives unexpected support from a visiting king, Iarbus, who promises to furnish the ships with sails and oars. Preparations are afoot for Æneas's voyage when Dido hears of them and is mad with grief. In vain she reminds Æneas of his protestations and vows ; he simply answers :

“ I am commanded by immortal Jove
To leave this town and pass to Italy,
And therefore must of force. ”

Dido makes one last appeal that seems the extremity of pathos :

“ Let me go, farewell, I must from hence.
These words are poison to poor Dido's soul.
O speak like my Aeneas, like my love.
Why looks't thou toward the sea ? the time hath been
When Dido's beauty chained thine eye to her :
Am I less fair than when thou sawest me first ?
O then Æneas, 'tis for grief of thee :
Say thou wilt stay in Carthage with the Queene,
And Dido's beauty will return again . . .
The Gods, what Gods be those that seek my death ?
Wherein have I offended Jupiter,
That he should take Æneas from my arms ?
O no, the Gods weigh not what lovers do,
It is Aeneas calls Æneas hence . . . ”

It fails too ; she turns to rate him roundly :

“ O serpent that came creeping from the shore,
And I for pity harboured in my bosom,
Wilt thou now slay me with thy venom'd sting,
And hiss at Dido for preserving thee ? ”

Æneas is gone while she is still venting her wrath, yet blinded by her tears. The nurse arrives at this juncture with the news that Aeneas's son had been mysteriously stolen away from her ; Anna, Dido's sister, brings the news that Æneas has sailed away indeed ; Dido would fain follow Æneas to Italy, but all the ships have already been taken away by the deceitful lover. What is there for Dido to live for ? She orders a sacrificial fire to be lit, and, alone in its presence, screams out the words :

“ Now Dido, with these relics burn thyself,
And make Æneas famous through the world,
For perjury and slaughter of a queen . . . ”

She burns the sword, the garments and the letters, and all the other tokens of Æneas, and curses him and his progeny ; then with the brief, “ Live false Aeneas, truest Dido dies,” she stabs herself and

throws herself into the flames. Iarbus arrives too late and kills himself ; his lover Anna, bereft at one blow of all love and support, kills herself too. And that is the end.

We have now to say a few words about Marlowe's unfinished poem, " Hero and Leander ". Marlowe got the idea from a Greek poem of the fifth century. But the treatment in " Hero and Leander " is all Marlowe's own. It has all the lilt and leap, the sensuous Paganism, the maddening frenzy, all the luscious extravagance of colour and sound that we have associated with the Renaissance. Its poetry has a morning freshness and assaults us with its rainbow radiance. The verses seem to bubble forth in perennial exultation. One desires to repeat the couplets for the sheer fascination of it : the phrases seem mystically to enchant us, the images to crush us with their opulence, to suffocate us with their intense perfume. How marvellous are these verbal embroideries ; Hero,

" She wore no gloves, for neither sun nor wind
Would burn or parch her hands, but to her mind,
Or warm or cool them, for they took delight
To play upon those hands, they were so white. "

And " since Hero's time hath half the world been black. " As for Leander,

" Some swore he was a maid in man's attire,
For in his looks were all that men desire. "

Hero has taken the vow of chastity and is an inmate of the temple. Leander meets her and they are both awakened into sudden and overwhelming love. He addresses to her long speeches, tells her she should transgress her vow, plies her with eloquent casuistry :

" Thereat she smiled, and did deny him so,
As put thereby, yet might he hope for mo,
Which makes him quickly reinforce his speech,
And her in humble manner thus beseech. "

She half relents and they meet in secret :

" O who can tell the greeting
These greedy lovers had at their first meeting.
He asked, she gave, and nothing was denied
Both to each other quickly were affied. . . .
Albeit Leander rude in Love, and raw,
Long dallying, with Hero, nothing saw
That might delight him more, yet he suspected
Some amorous rites or other were neglected. "

He leaves her for the time, but soon his passion is aflame and he swims the Abydos and returns to her bedouir again at night,

" She stayed not for her robes, but straight arose,
And drunk with gladness, to the door she goes,
Where seeing a naked man, she shrieked for fear . . .
And ran into the dark herself to hide."

Little by little she is at home with him,

" And every kiss to her was as a charm,
And to Leander as a fresh alarm,
So that the truce was broke, and she alas,
(Poor silly maiden) at his mercy was."

It is all over with her and him, and love's first round is finished ;

" And now she wish'd this night were never done,
And sigh'd to think upon the approaching sun . . . "

Marlowe wrote only two sestiads, but Chapman wrote the remaining four, vehemently underlining its moral. Chapman's sequel has none of the scintillating glow of Marlowe's incomparable fragment ; for, in dealing with a story like this, to which such a faery-mad back-ground has been supplied by Marlowe, it is not enough to speak out "loud and bold." Something else, an ecstatic lyrical fervour, is required too ; and this Chapman could not give. Great praise has been bestowed upon Marlowe for this most exquisite of poems. Swinburne said dithyrambically that it "stands out amid all the wide and wild poetic wealth of its teeming and turbulent age, as might a small shrine of Parian sculpture amid the rank splendour of a tropic jungle." Mr. Tucker Brooke, one of the most competent of Marlowe's editors, remarks : " It is doubtful whether the English heroic couplet through all its varied and honourable history from the time of Chaucer to that of John Keats, has ever been used with more perfect melody or more wonderful understanding of its peculiar capabilities than in the first two sestiads of ' Hero and Leander.' " Professor Saintsbury has judiciously observed : " The riot of passion and of delight in the beauty of colour and form which characterises his version of ' Hero and Leander ' has never been approached by any writer." And one has only to compare the poem with Shakespeare's own " Venus and Adonis " to realise how much more fresh, free and satisfying Marlowe's poem is than the other. Marlowe wrote also that fine, than which nothing can be finer, inevitable anthology piece entitled, " The Passionate Shepherd to his Love ", which begins with the wonderful stanza :

" Come live with me, and be my love,
And we will all the pleasures prove,
That hills and valleys, dale and field,
And all the craggy mountains yield."

With what relish should the Elizabethans have drunk its felicitous

music ! No wonder they identified Marlowe's death with Dr. Faustus's tragedy :

" Cut is the branch that might have grown full straight
And burnt is Apollo's laurel bough. . . . "

It would be to little purpose to discuss in this paper the plays in the Marlovian Apocrypha,—plays like " Lust's Dominion " and " True Tragedy of Richard, Duke of York." What Professor Saintsbury calls the "*ne plus ultra* of the poetic powers " is but very rarely or fitfully present in these plays. We will therefore pass on to a consideration of one or two aspects of Marlovian criticism. First, then, about the charges levelled against Marlowe : it is maintained that Marlowe totally lacked a sense of humour, and that, secondly, he was incapable of sketching a credible, not to say a noble, woman character. Now, what do we exactly mean by humour ? Our ideas of humour, formulated after a study of Aristophanes or Molière or even Ben Jonson, have very little relevance to such humour as we associate with Falstaff and Uncle Toby and Micawber. In other words, the humour of the typical Englishman is a thing *sui generis*, and might be described as the playful faculty of the imagination that delights in the discovery and exhibition of the incongruous, the ludicrous and the droll. And how is this humour differentiated from the Aristophanic, or the ' continental ' humour ? The difference is almost the difference between humour and wit. We might say that humour has more of geniality, generosity, and humanity than wit and much less of intellectual subtlety and keen-told analysis. Humour indeed is slow, gradual, and with just a smile insinuates its fun into your heart : but wit is startling, abrupt, incisive and destructive. Who shall say which, humour or wit, is the finer or nobler or greater human activity ? Father Ronald Knox in the introductory essay to his " Essays in Satire " seems to deprecate humour. Laughter, no doubt, is the special prerogative of man : Father Knox believes this as firmly as Mr. Martin Armstrong. But laughter can arise, if authorities like Bergson are to be trusted, either out of incongruity or out of irreverence. If out of incongruity, the source of laughter is humour ; if out of irreverence, the source of laughter is satire. Father Knox complains that the laughter that is caused by humour is as happy as it is futile. Laughter was given to man to be used as a weapon, and he simplified it or vulgarised it into a toy. If on the contrary laughter is reserved for satire or wit, then it may be used to condemn or reform. Father Knox almost seems to say that if humour is no more than the cause of uproarious laughter, then the less humour is, and the more futile the laughter : they have both debased themselves by too much currency. But the laugh that Swift or Samuel Butler or Aldous Huxley evokes is one that corrects and tends to improve :

it may be a grim laugh, it may be even inhuman, yet it has a high purpose. People who agree with Father Knox will find the humour of Mr. P. G. Wodehouse or of any of our innumerable entertainers a little bit misplaced and extravagant. Mr. Denys Thompson, for instance, in his "Reading and Discrimination" speaks of "the tedious trifling of Lamb", of the modern essayist exploiting "the fake personality" and of the modern essay being used "as a profitable channel for vulgarity, 'low-brow' propaganda, and a studied irresponsibility." At the other end of the scale we have people like Mr. Ernest Raymond who prefer English humour to Europe's wit and in fact equate this humour with "an unexpressed, generally unconscious, Franciscan mysticism." Mr. Raymond writes with rare gusto and the examples he cites in his fascinating "Through Literature to Life" nearly carry conviction. He discusses Molière, Cervantes, Gogol, Doestoevsky, and even the Irish Swift and Shaw, and concludes they none of them are so completely possessed by the "swelling pity that is nine parts of our ridicule." Humour of this type is in abundance in Chaucer, in Shakespeare, in Dickens, and in our own times, in Mr. Priestley and the late Arnold Bennet. It is no use trying to evaluate the material advantage accruing to us from such humour. Such expansiveness, such robust felicity that we find in "Henry IV" or "The Good Companions" produces a general lightening of the "weary weight of all this unintelligible world", and surely that is a lot to be thankful for. Mr. H. W. Fowler notes precisely in his "Modern English Usage" that humour has "human nature" for its province, while wit, satire and sarcasm have as their respective provinces "words and ideas", "morals and manners" and "faults and foibles." Of all these human faculties, humour certainly deserves to carry off the palm, since it has human nature itself, and with it all our experience, for its province. But wit, satire and sarcasm have too their own uses in literature, and to recognise them is no more than their due. Considering Marlowe in the light of the foregoing remarks, it must be at once stated that in his published dramas he has not given specimens of the pure English humour that is "flushed through with pity and love" What then? Does lack of humour convict Marlowe of lack of a sense of proportion as well? I do not think it necessarily follows. I may state my view in some such words as: humour deals with human nature, wit with words and ideas, satire with morals and manners, and sarcasm with faults and foibles; what makes humour or wit or satire or sarcasm possible is the unfailing sense of proportion in the writer (or speaker) that immediately detects some disharmony or incongruity in the particular province it, for the time being, works: and thus the man who through humour discovers the incongruities in our nature or through satire

exposes any moral perversity, is engaged in more or less the same thing; the activity is different in degree, not in kind. My point is that though Marlowe is not a master of humour in the sense Shakespeare or Dickens or Sterne is one, he is not without the intuition to see life steadily and see it whole; Marlowe too can detect disharmonies in life or conduct and expose them, though (by preference probably) his range was more restricted than Shakespeare's. I have been at pains here to controvert the view that maintains that because Marlowe was not 'humorous', therefore he suffered from a frantic want of balance, that he had no sense of proportion. I rather feel that Marlowe, for his age, had considerable powers of self-criticism and that he was endowed with the inner light that could pierce through hypocrisies and annihilate casuistries. This faculty may be called 'humour' in a special sense: the grim, sardonic humour that is half satire and half caricature. Here is an excerpt from *The Jew of Malta*:

" Friar 2. Thou hast committed—

Barabas. Fornication? but that was in another country:
And besides, the wench is dead."

Perhaps we laugh, and if we do, it is irreverent laughter. The grimness of this humour is appalling and the above extract has actually served as motto to Mr. T. S. Eliot's challenging poem, "The Portrait of a Lady." Is it after all so very different from the type of irreverent humour described by Mr Raymond thus: "if Mr Max Beerbohm shows us in a cartoon the late King Edward VII, when long past middle age, being stood in the corner by his mother, we are, I am ashamed to say, pleasantly tickled by the irreverence, though in this case our pleasure may be marred by *too much* shock"? Yes, the pleasure is marred by *too much* shock: here is another bit of conversation from the same scene:

" Ithamore. But here's a royal monastery hard by,
Good master let me poison all the monks.

Barabas. Thou shalt not need, for now the nuns are dead,
They'll die of grief."

In vacuum it is mere sniggering vulgarity: but in the play it is appropriate enough. We are shocked and yet we cannot help smiling, a little mischievously, at the tiny monster of truth revealed. Such laughter as this Marlowe often gives, though we might readily admit that it is a laughter of malice or even of hate. Without a doubt, it all seems arid by the side of such heartiness and such unabashed happiness as Falstaff and Toby Belch and Bully Bottom can give us. In all these instances the humour proceeds from the uniqueness of the characters, not from the mere absurdity of the

situations. Yet one has to remember that Shakespeare himself in plays like "A Comedy of Errors" went through a period of nonage when situation rather than character afforded a medium for humour. Why then should we make much of the fact that in his *tragedies* Marlowe does not give us the pure humour that Shakespeare evolved only in his *mature comedies*?

In the poem "Hero and Leander", again, Marlowe's humour has a curious cast. The chance moralisings have a quaintness that is half sarcasm and half caricature :

" Women are won when they begin to jar . . .
 " Maids are not won by brutish force and might,
 But speeches full of pleasure and delight . . .
 " Jewels being lost are found again, this never,
 'Tis lost but once, and once lost, lost for ever . . .
 " But love resisted once, grows passionate,
 And nothing more than counsel lovers hate . . .
 " Seeming not won, yet won she was at length,
 In such wars women use but half their strength . . . "

These worldly-wise statements inevitably draw out our smiles and they are perfectly in keeping with the atmosphere of the poem. Marlowe's aim was to capture the dawn of adolescence ; and when we read the poem, the halo of its circumambient magic keeps our intellectual faculties in thrall. But at length we cannot be blind to the fact that Marlowe has been at pains to paint the other side of the medal too,—to tear away, as tenderly as he may, the veils of hypocrisy the young lovers are wearing. It is then we relish the above quoted, otherwise sententious, passages. The arguments Leander advances to Hero, trying to win her love, are similarly couched in terms that but thinly veil their self-deception :

" One is no number, maids are nothing then,
 Without the sweet society of men . . .
 " Believe me Hero, honour is not won,
 Until some honourable deed be done . . .
 " Rich robes themselves and others do adorn,
 Neither themselves nor others, if not worn . . . "

Almost in the same vein is Viola's admonition to Olivia in "Twelfth Night" :

" Lady, you are the cruell'st she alive,
 If you will lead these graces to the grave
 And leave the world no copy."

Enough has been said to show that Marlowe did not lack a sense of humour, though he might have lacked that particular concoction of humour that Falstaff later brought into currency. The

fact was, Marlowe took the matter more seriously; he would raise laughter less often, but every time it would be a weapon rather than a toy. In an acute bit of criticism, Mr T. S. Eliot remarks that *The Jew of Malta* may be interpreted not as a tragedy, not as 'tragedy of blood', but as a 'farce', "farce of the old English humour, the terribly serious, even savage comic humour, the humour which spent its last breath in the decadent genius of Dickens." Not *The Jew of Malta* only, but the other plays of Marlowe too are in their genre such farces, farces that jerk out savage laughter in the very impulsion of their tragedy. Tamburlaine and Faustus and Barabas and Mortimer and Guise and Dido are all credible only in the enchanted island reared up by the Marlovian verse; but in this our land of fact they are caricatures all, futilities and failures all.

The other charge against Marlowe is no less serious and no less mistaken. The charge runs: Marlowe was no adept in characterisation; he could paint only one fixed type of character that is all ambition and no love, all sound and fury and of little poignant human significance. Here again the critics are asking too much. Marlowe's career as a dramatist extended to less than five years probably, and he was dead before the age at which Shakespeare was still fumbling uncertainly with other people's plays. Even then, what an abundance of creative power Marlowe had displayed! Tamburlaine, Faustus, Barabas, Mortimer, Abigail, Dido, Catherine, Ithamore, Guise, Prince Edward, Mephistophilis, Bajazeth,—they are all striking figures and not one of them would fade from the memory. The man who could with such delicacy portray the love of Dido for Aeneas or the curious though sincere filial solicitude of Abigail for Barabas cannot certainly be criticised for his inability to portray women. Nor are all Marlowe's characters strong of will, giants in the midst of pigmies. Edward can dominate a scene with his helplessness as surely as Tamburlaine can with his triumphs; the tortures Bajazeth and his wife undergo are of their kind very touching indeed; and not many dramatists have succeeded in making boys as credible as Prince Edward is in *Edward II*:

"Mother, persuade me not to wear the crown,
Let him be king, I am too young to reign . . .

"My lord, if you will let my uncle live,
I'll requite it when I come of age . . .

"What safety may I look for at his hands,
If that my uncle shall be murdered thus? . . .

" . . . accursed head,
Could I have ruled thee then, as I do now,

Thou hadst not hatch'd this monstrous treachery ?
 Here comes the hearse, help me to mourn, my lords :
 Sweet father here, unto thy murdered ghost,
 I offer up this wicked traitor's head,
 And let these tears distilling from mine eyes,
 Be witness of my grief and innocencie."

Psychologically there is nothing surprising in Prince Edward's words or actions ; he is natural throughout. Again, in *Dido, Queen of Carthage* the little boy, Ascanius, is a lovely, happy thing :

"Asca. Madame, you shall be my mother.

Dido. And so I will, sweet child : be merry man,
 Here's to thy better fortune and good stars."

Marlowe, daring inventor that he was, was ceaselessly experimenting. He had tried to sketch people at once as romantic projections and as laughable caricatures ; he had tried to make angels and devils human and human beings nearly superhuman or inhuman ; he had incessantly shaken the kaleidoscope of Character to draw yet newer patterns for our edification. What grim humour lurked in his brain when he was working at these juggleries ? He should have mightily enjoyed writing his plays and poems : were they not in sum his own original world, foil to the hard world of fact ?

A further vexed question is this : how far, or whether at all, Shakespeare was indebted to Marlowe ? Idolaters of the Bard of Avon often think it their duty to deny Marlowe's influence in toto. It is necessary in this connection to get the things in historical perspective. Marlowe was born in the same year as Shakespeare, but the former's academic laurels and consequent status in London society placed him at an initial advantage. But that by itself was not all. Marlowe deliberately became a dramatist while Shakespeare merely, almost unconsciously, gravitated to and at last possessed drama. Like so many others of his contemporaries, Shakespeare must have been dazzled by this new star. He should have been among those who "would spurn their sleep in still dark night to meditate upon his (Marlowe's) golden lines." Shakespeare must have been among those who met at the "Mermaid" tavern ; the great contemporaries should have talked things with fervour and with heat ; they should have collaborated on a play or two, or perhaps more. Then Shakespeare wrote his first plays : comedies like "Love's Labours Lost" and "The Comedy of Errors" and a tragedy like "Titus Andronicus." Most probably Shakespeare did no more than revise these plays. Soon Shakespeare was at work on other comedies and tragedies, particularly on "Richard III" and Richard II." And both these

plays seem to be drenched in Marlowe. In the words of Prof. Schelling: "Richard is conceived, by the help of tradition and previous stage representation, as a monster of moral depravity, a figure of heroic proportions and heroic wickedness and perfidy, stalking through life regardless of anything but his own ruthless ambition. This is Marlowe's conception of the tragic protagonist and comparable not only in conception but alike in execution—in a certain largeness of phrase, force of passion and objectiveness of poetic spirit—with Tamburlaine, Faustus and Barabas."

We have already drawn attention to the similarity between the long opening soliloquies of Richard III and the Duke of Guise. We might notice again the grouping of villain and accomplice: Barabas and Ithamore in *The Jew of Malta*, Richard and the Duke of Buckingham in "Richard III", who are, in Mr. E. E. Stoll's suggestive phrase, "crocodiles caressing and caressed." Queen Margaret's curses have the tang of Bajazeth's: says Margaret—

"Earth gapes, hell burns, fiends roar, saints pray,
To have him suddenly conveyed from hence.
Cancel his bond of life, dear God, I pray,
That I may live to say, 'The Dog is dead!'"

And Zabina, not less virulent than her husband Bajazeth, cries:

"Let all the swords and lances in the field
Stick in his breast as in their proper rooms!
At every pore let blood come dropping forth,
That ling'ring pains may massacre his heart,
And madness send his damn'd soul to hell!"

What Mr. Scott-James calls "the torrent of Marlowe's eloquence which mingled fantastic brutality with sweetness" seems new-born in the altercations between Margaret, Elizabeth and the Duchess of York in Shakespeare's play, distinctly reproducing similar things in the verbal passage at arms between Zenocrate and Zabina in Marlowe's play. Even the occasional humour in "Richard III" is of the grimmest Marlovian hue:

"Anne. O, he was gentle, mild, and virtuous.
Glou. The better for the King of Heaven that hath him.
Anne. He is in heaven where thou shalt never come.
Glou. Let him thank me, that help to send him hither;
For he was fitter for that place than earth.
Anne. And thou unfit for any place but hell.
Glou. Yes, one place else, if you will hear me name it.
Anne. Some dungeon.
Glou. Your bed-chamber."

The influence of Marlowe can nearly as palpably be discerned in Shakespeare's "Richard II." Edward II and Richard II are weak-willed kings both, are both forced to abdicate, are both thrilling poets till the last, from which realm neither Mortimer nor Bolingbroke could dispossess them. These are the words of Edward when he resigns his crown :

" . . . Here receive my crown.
 Receive it? no, these innocent hands of mine
 Shall not be guilty of so foul a crime,
 He of you all that most desires my blood,
 And will be called the murderer of a king,
 Take it : what, are you moved, pity you me ?
 Then send for unrelenting Mortimer
 And Isabel, whose eyes being turned to steel,
 Will sooner spark fire than shed a tear . . .
 Come death, and with thy fingers close my eyes,
 Or if I live, let me forget myself."

Here are Richard's words :

" . . . Here, cousin, seize the crown ;
 Here, cousin,
 On this side my hand, and on that side thine.
 Now is the golden crown like a deep well
 That owes two buckets, filling one another,
 The emptier ever dancing in the air,
 The other down, unseen, and full of water.
 That bucket down, and full of tears am I,
 Drinking my griefs, whilst you mount up on high . . .
 You may my glories and my state dispose,
 But not my griefs : still am I king of those."

The situation is the same, and the imitation is apparent, and yet Shakespeare has already invented his incomparable wand and waved it, giving to words a complex fury of expression that makes thought, passion and poetry one. The words assert themselves and triumph, even more than they did in Marlowe. But all the same, Shakespeare's indebtedness to Marlowe is clear. Is it not significant that Shakespeare did not too soon dare to challenge Marlowe on his own ground ? Till nearly thirty-five years of age, Shakespeare did not attempt to write any of his superb dramas. "Romeo and Juliet" was a lyrical romance ; other early tragedies like "Titus Andronicus" "Richard III" and "Richard II" were variations on the Marlovian theme and no more. Even in his early comedies, and later in "The Merchant of Venice", Shakespeare gives ample evidence of his own acceptance of Marlowe's leadership. The extent of his borrowings from *The Jew*

of *Malta* in his "The Merchant of Venice" has been discussed by several critics, for instance by Professor Levin Schucking ("Character Problems in Shakespeare's Plays", pp 88-92) and Mr. Stoll ("Shakespeare Studies", pp 269-71). Barabas and Abigail clearly foreshadow the Shylock and Jessica of Shakespeare's play. A sentence from Professor Schucking may be quoted in this context: "Marlowe's play was all the more useful as its hero already possessed, to a very noticeable degree, that quality of Shylock which most critics agree in overlooking, viz., his servile and repulsive politeness, which so surprisingly appears in the scene with Antonio (1, iii); we find the Jew of Malta commenting upon this trait with that self-characterisation which is quite usual in Marlowe's works as well as Shakespeare's." The Barabas speech referred to is:

"We jews can fawn like spaniels when we please;
And when we grin we bite, yet are our looks
As innocent and harmless as a lamb's."

We might compare also these speeches of the two jews:

"Barabas. Why, I esteem the injury far less,
To take the lives of miserable men,
Than be the causers of their misery.
You have my wealth, the labour of my life,
The comfort of mine age, my children's hope,
And therefore never distinguish of the wrong."

"Shylock. Nay, take my life and all; pardon not that.
You take my house when you do take the prop
That doth sustain my house; you take my life
When you do take the means whereby I live."

Such pairs of passages go far to prove the justness of Mr. Eliot's statement: "when Shakespeare borrowed from him (Marlowe), which was pretty often at the beginning, Shakespeare made something inferior or something different." What is really to the point is that there was in Shakespeare's career an undeniable period of tutelage to the then all conquering Marlowe. In admitting this, we strictly keep to the facts: on the contrary, Swinburne's view that Marlowe "first, and he alone, guided Shakespeare into the right way of work" is just like several others of his judgments,—it is a misleading and fictitious exaggeration.

A lot has been written about Marlowe's unique contribution to the development of blank verse. He is not, of course, the creator of blank verse in English; that credit probably goes to the Earl of Surrey, whose translation of the second and fourth books of the "Aeneid", although wooden and stiff as yet, showed to his countrymen what a potent weapon they had in this new medium of

poetic expression. What Marlowe really did was to infuse into the inanimate frame-work of Surrey's verse the promethean heat that transformed it into a succession of mighty lines, a fit vehicle now for expressing rapture or limitless desire. How did he achieve this extraordinary change ? Surely, with his so irrepressible imagination that is, in Mr. Arthur Symonds's words, " filled with fire and flame, with smoke and hell's fumes ; with the savourous scent of incense, with the bitter taste of unshed tears, "—in other words, with his genius. But this is really begging the question ; we should be able, besides, to discover the art and artifices that Marlowe consciously or unconsciously employed to achieve his object. Mr. Churton Collins has given a comprehensive analysis of Marlowe's blank verse : " If we examine the mechanism of his verse, we shall see that it differed from that of his predecessors in the resolution of the iambic into tribrachs and dactyls, in the frequent substitution of trochees and phyrhics for monosyllables, in the large admixture of anapaests, in the interspersion of Alexandrines, in the shifting of the pauses, in the use of the hemistichs, in the interlinking of verse with verse." We shall mark the progress by means of a few quotations arranged chronologically : first, these from Surrey's " Aeneid " :

" These ruthful things that I myself beheld,
And whereof no small part fell to my share :
Which to express, who could refrain from tears ?"

next, these lines from " Gorboduc " :

" And truth thereby vested in subjects' hearts,
To owe faith there where right is known to rest. "

and these from Greene :

"You of the bench, and you, my fellow friends,
Neighbours, we subjects all unto the king;
We are English born, and therefore Edward's friends..."

How different is the ring when we hear Marlowe in divers moods, in ecstasy as in :

"O my girl,
My gold, my fortune, my felicity !
O girl, O gold, O beauty, O my bliss !"

in the extremity of anguish as in :

" Behold me here, divine Zenocrate,
Raving impatient, desperate and mad..."

or in :

"See, see, where Christ's blood streams in the firmament !"
in feeling admonition as in :

" Break heart, drop blood, and mingle it with tears,
Tears falling from repentent heaviness

Of thy most vile and loathsome filthiness,
 The stench whereof corrupts the inward soul
 With such flagitious crimes of heinous sins
 As no commiseration may expel..."

Several of the things mentioned by Mr. Churton Collins may be noticed in the passages quoted above or elsewhere in this paper, in fact in every authentic Marlovian passage. Mr. Robertson and, following him, Mr. Eliot, have found several imitations of and improvements upon Spenser in Marlowe; and Mr. Eliot adds: "The verse accomplishments of *Tamburlaine* are notably two: Marlowe gets into blank verse the melody of Spenser, and he gets a new driving power by reinforcing the sentence period against the line period. The rapid long sentence, running line into line. . . . marks the certain escape of blank verse from the rhymed couplet, and from the elegiac or rather pastoral note of Surrey. . . . In *Faustus* Marlowe went further: he broke up the line, to a gain in intensity, in the last soliloquy: and he developed a new and important conversational tone in the dialogues of *Faustus* with the devil. . . . The account of the sack of Troy (in *Dido*) is in this newest style of Marlowe's, this style which secures its emphasis by always hesitating on the edge of caricature at the right moment." It all amounts to saying that Marlowe was making his verse ever increasingly approximate to the idea, so that, there might be effected a perfect fusion of form and substance; he was teaching his verse to be not merely mighty but also to be supple, malleable, intense, deceitful and amusing.

It is time this paper were concluded. Marlowe is one of those poets whom one adores intensely or hates as much. He is indisputably one of the grand Napoleons in the realm of verse. Alas, no Bradley has yet discussed elaborately the "substance of Marlovian tragedy"; no Moulton has yet discoursed on "Marlowe as a Dramatic Artist." But there is an enthusiastic paper in Vol. III of the English Association's annual "Essays and Studies" devoted to a discussion of the dramatic technique of Marlowe. Its author, Mr. George P. Baker, has some very interesting things to say about the two Parts of *Tamburlaine* and *Edward II*. He shows that Marlowe's departures from the historical material at his disposal were necessary for the greater unity and coherence of his plots. One or two sentences may be appropriately quoted here: "In *Tamburlaine* he passes from unifying episodes to treating episodes unified into a keen study of character. In *Edward II* by rousing interest promptly; by remassing his materials so as to maintain interest; by creating and developing a contrasting sub-plot (Isabella-Mortimer story); and by motivation of character he reveals himself a genuine

tactician. That is, he wrote vividly aware of the stage on which his plays would be given and of its audience." And no more than that we could ask of him. Marlowe's plays were a roaring success when first they were performed ; people probably neither noticed the so-called bombast nor cared for the piled-up murders ; probably they really were thrilled to the roots of their being, hearing those speeches and witnessing those scenes. M. Taine writes, referring to Marlowe's plays : "All this is pretty strong, you will say : these people kill too readily, and too quickly. It is on this very account that the painting is a true one." That is to say, in Elizabethan England, with so many Italian novelettes floating about describing the oddest crimes, and with strange exaggerations in practice somehow connected with the Renescent ideal, Marlowe's tragedies were felt to be quite in tune with the rest.

To summarise in a sentence the Marlovian ideal of tragedy is too risky a thing. It is apparent that he was very much in sympathy with Machiavelli's views as expressed in his "The Prince." Machiavelli after all was only integrating in his thesis the various Renescent ideals of conduct proceeding from an unashamed individualism. Virtù,—that was to be the Renescent God ; in so far as virtue was that quality in a man that urged him to forge his own career and realise his own potentialities untrammelled by the dead weight of tradition, Tamburlaine and Faustus and Barabas have their particular virtù and well answer the Machiavellian ideal. In the second place, Marlowe seems to have fully accepted the Renescent notion of individual worth as opposed to hereditary right. Marlowe seems positively to relish the sight of princes and emperors impotently kowtowing to such super-men as Tamburlaine and Faustus, Barabas and Mortimer ; he again and again represents kings as cowards and weak-willed and some sundry individuals as nobly gifted to dare even the immortal gods. Marlowe thus would make heroes of ordinary human beings, but people who by sheer exertion assume the proportions of Titans. Not fate is the motive-force of tragedy in Marlowe, as it is in Greek drama ; it is rather the struggle between the hero and his surroundings, the struggle in which the hero generally fails at last. Tamburlaine himself finds himself impotent against the forces of disease and death ; Faustus and Barabas and Mortimer, they are all vanquished in the end. But while the fight lasted, it had been most thrilling, and that, in a Marlovian tragedy, is everything. But though vanquished in the end, the heroes yet seem to say with Henley :

" In the fell clutch of circumstance
I have not winced nor cried aloud.
Under the bludgeonings of chance
My head is bloody, but unbowed."

Of Marlowe's heroes, only Faustus seems to whine in the end ; and this, it seems more than likely, rather falsifies Marlowe's own view-point ; it should have been a concession to the prevalent sentiment of his audiences. All his other heroes meet death bravely. They seem to "ne wish for death, ne fear his might." Taking the plays as a whole, the recurrent note that is struck appears to be a superior contempt "for earthly limitations and the yearning to glut human desires with a completeness denied in this world" (Boas). And in order to produce this illusion of unearthly power, to create these supermen, these Gullivers amongst Lilliputians, Marlowe often had to take his audience to distant lands, speak of the unlikeliest kingdoms, and to chronicle men and women so different from the English. He found in the newly published map "Theatrum orbis Terrarum" by Ortelius the open sesame, as it were, of his imagination. Poring over its lines and curves, lisping the polysyllabic names of rivers and mountains and distant territories, his fancy took wings, and as he sat down to write, the numbers came in their luxuriant and rich formation. What really happened to Marlowe, and through him to English dramatic poetry, is finely described by Ethel Seaton in the suggestive paper "Marlowe's Map", from which the following passage may be abstracted here : "He (Marlowe) was playing a great game of chess, with kings and conquerors for pieces, and for chessboard, the *Theatrum orbis Terrarum : a Kriegspiel*, . . . but his game, being imaginary, without our bitter urgency, was excellent sport . . . from the bare outlines of maps, and perhaps from the dry statements of Cosmographers, he 'bodied forth the forms of things unknown'. He saw the Polar cliffs as 'rocks of shining pearl' ; he heard the boisterous waves of raging Lantchidol beat on an unchartered coast. He pondered over the great Atlas till the countries 'came alive', and the creatures of his brain went through such adventures as fell to the lot of many an Englishmen of his time." To Marlowe, then, poetry was supreme sport ; to imagine things, to project them finally and permanently into the realm of poetry, to make of man a higher and a greater than he is,—these were Marlowe's sport, and hence certainly he deserves Swinburne's encomium, "He is the greatest discoverer, the most daring and inspired pioneer, in all our poetic literature."

K. R. SRINIVASA IYENGAR.

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ANOTHER SHAKESPEARE CRUX.

In Macbeth I. V. 19 occurs a passage upon which much critical ink has spilt. I quote the passage from the Cambridge Shakespeare edited by Aldis Wright.

Thou 'ldst have, great Glamis,
That which cries ' Thus then must do, if thou have it ;
And that which rather than dost fear to do
Than wishest should be undone.'

The passage has presented so many problems that the Cambridge editor gives it a critical note to itself. In this note he is sufficiently judicial to offer no opinion of his own, in this resembling most commentators coram cruce. But he records his judgment in the text he prints.

His note reads :

NOTE I.

I. 5. 19-22. Pope was the first to place the words 'Thus thou . . . undone' in inverted commas, and was followed substantially by all subsequent editors with the exception of those we are about to mention. Hanmer printed in italics 'This thou must do if thou have it' only, and was followed by Capell and Mr. Staunton, except that they restore the original reading 'Thus' for 'This'. Johnson proposed to read 'me' for 'it' in line 20, printing in italics the same words which Pope included in inverted commas. His reading was adopted by Rann. D. A. Hunter (Harry Rowe) read :

"Thou' dst have, great Glamis,
That which cries, *Thus thou must do, if thou have me ;*
And that's what rather thou dost fear to do,
Than wishest should be undone.'

Mr. Joseph Hunter (*New Illustrations &c. of Shakspeare*, II. p. 172) proposed to mark the words 'Thus thou must do' only as a quotation, and to read line 20 thus :

"That which cries "Thus thou must do" if thou wouldst have it.'
The Variorum edition of the play is even fuller of possibilities.

Both the Cambridge Edition note and the Variorum Edition seem to me to miss certain essentials. They all presume that what, in the opinion of Lady Macbeth, Macbeth would have, are, (i) the throne of Scotland, (ii) the disappearance of Duncan.

Now let us remember that from the point of view of Lady Macbeth (ii) is a necessary antecedent to (i) and that to her clear vision the two are one.

Remembering this, let us view the earlier part of her speech, and let us note that it is cast in a euphuistic mould ; and that, in it, she lisps in antitheses for the antitheses come. It is therefore both artistically and psychologically necessary that her culminating remark should be antithetical. For the reasons already adduced, I claim that between 'the taking off of Duncan,' and the throne of Scotland there is, for Lady Macbeth, no antithesis whatsoever.

In Shakespeare's time punctuation was in its infancy and serious proof reading not yet conceived. Punctuation was either grammatical, rhetorical or histrionic, according to the fancy of the punctuator. There is, therefore, from the Folio no evidence to be drawn from its punctuation.

One past Editor had a glimmer of light, but it failed him. He is Mr. Joseph Hunter. Let us follow his glean and ignore his proposed alteration of the verse for (*difficilior lectio senper probabilior*) we must try to keep to the words of the text.

Let us punctuate thus :

Thou 'ldst have, Great Glamis,
That which cries, 'Thus thou must do', if thou have it ;
And that which rather than dust fear to do
Than wishest should be undone.

There is but one thing which tells a man his duty. It is the voice of conscience. If he has a conscience it will speak. In the opinion of Lady Macbeth, her husband would like to be a man of conscience.

Thou'ldst have, great Glamis,

That which cries, 'Thus thou must do', if thou have it, But, at the same time, the seeds of corruption have begun to mortify the categorical imperative within him, and so he'd have the death of Duncan—

That which rather thou dost fear to do
Than wishest should be undone.

This very simple adjustment of the orthodox punctuation saves us from all necessity of suggesting with Dr. Johnson that Shakespeare wrote it 'when he meant 'me', or that when he wrote 'if thou have it' he meant 'if thou'ldst have me.'

H. HAMILL.

THE *ĀPRĪ* HYMNS IN THE *ṚGVEDA*.*

[Translated into English and briefly annotated.]

By

V. A. Gadgil.

INTRODUCTION.

1. It is generally believed that the *Āprī* hymns form a liturgical introduction to an animal sacrifice. The word *āprī* can be derived either from $\bar{a} + \sqrt{pr}$ 'to fill' or from $\bar{a} + \sqrt{pri}$ 'to please,' to gratify; both the derivations are suggested at Sat. Br. III.8.1.2 [*āpriṇāti* 'fills'] & VI.2.1.28-31 [*āpriṇāti* 'pleases']. More probable is the second derivation which corresponds to the Zend *afrinaiti*. These ten *Āprī* hymns are evidently composed for sacrificial purposes as their construction is very artificial. They consist generally of 11 ṛks each of which is addressed to a separate deified object connected with sacrifice. The usual order of the verses is as follows:—First verse, to Agni either as the *samiddhah* 'the enkindled one' (cf. I. 13; 142; 188; II. 3; IX. 5; V. 5; X. 110) or as the receiver of *samidh* (cf. III. 4; VII. 2; X. 70). Second verse, either to *Narāśamsa* (cf. I. 13; 142; II. 3; V. 5; VII. 2; X. 70) or to *Tanūnapāt* (cf. I. 13; 142; 188; III. 4; IX. 5; X. 110). Both the deities are invoked to spread honey and ghee over the sacrificial oblation. Third verse, to Agni associated with \sqrt{id} 'to praise,' as its object (cf. I. 13; 142; 188; II. 3; V. 5; VII. 2; IX. 5; X. 70; 110; only once, that too perhaps through oversight, is Agni connected with *id* or *ir*, 'the sacrificial food'. cf. III. 4;). Fourth verse, to *Barhih*. Fifth verse, to *Devīr Dvārah*. Sixth verse, to *Uṣāśā-Naktau*. Seventh verse, to *Daiṇyau hotarau* (see note on I. 13.8.) Eighth verse, to the three goddesses, *Saraswatī*, *Ilā*, *Bhārati* (for *Mahī* see note on I.13.9). Ninth verse, to *Tvastr* whose function is to bestow fruitful genital vigour upon the worshippers. Tenth verse, to *Vanaspati*, the sacrificial post. Eleventh verse, to the *Svāhākṛtis* which are the exclamation '*Svāhā*' pronounced over the oblations offered to the favourite deities of the poet.

2. These *Āprī* hymns belong to ten different families of Ṛsis. cf. M. Müller, History, p. 463 (*Kāṇvas* I. 13; *Āṅgirasas* I. 142; *Agastis* I. 188; *Śaunakas* i.e. *Gṛtsamada* family II.3; *Viśvāmitras* III.4; *Atris* V.5;

* I am deeply indebted to Professor Velankar, my teacher and colleague for initiating me into the field of Ṛgvedic studies and for making helpful suggestions to me from time to time.

Vasiṣṭhas VII. 2 ; Kāśyapas IX. 5 ; Bādhryaśvas X.70 ; Jāmadagnyas X.110). Out of these ten families four families (Śaunakas II.3; Atris V.5 ; Vasiṣṭhas VII.2 ; Bādhryaśvas X.70) invoke *Narāśamsa* only ; other four (Agastis I.188 ; Viśvāmitras III.4 ; Kāśyapas IX.5 ; Jāmadagnyas X.110;) invoke *Tanūnapāt* only ; while the remaining two families (Kānvas I.13; Āngirasas I.142) invoke both *Narāśamsa* and *Tanūnapāt*. According to the Āśvalāyana Śrauta-sūtra III.2, those who belong to the Śaunakas should use the *Āprī* hymn of Ṛṣisamada i.e. II.3 ; those belonging to the Vasiṣṭhas should use the *Āprī* of Vasiṣṭha i.e. VII. 2 ; and all other families excepting those of the Śaunakas and the Vasiṣṭhas may either use the *Āprī* hymns of their own Ṛṣis or may even choose the *Āprī* of Jamadagni i.e. X. 110. From this statement it appears that the *Āprī* hymns of the VII and II mandalas must have formed a group by themselves apart from the remaining 8 *Āprī* hymns which may have been composed later in imitation of these two. The statement that the Ṛṣisamadas and the Vasiṣṭhas must use their own *Āprī* hymns, and are not allowed to choose any other *Āprī* hymn, must have a very long history behind it. It is interesting to note in this connection that both the Ṛṣisamadas and the Vasiṣṭhas invoke *Narāśamsa* in their *Āprīs*, whereas the Jāmadagnyas and the Viśvāmitras invoke *Tanūnapāt*. The traditional hostility between the Vasiṣṭhas and the Viśvāmitras is a fact well known to vedic scholars. Under these circumstances it is quite conceivable that Viśvāmitra should not follow Vasiṣṭha in the use of the *Āprī* and should invoke *Tanūnapāt* in place of *Narāśamsa*, and that the families of the Atris and the Bādhryaśvas may have followed the example of the Vasiṣṭhas, while those of Agastya, Kāśyapa and Jamadagni may have followed Viśvāmitra or in view of the priority of Jamadagni to Viśvāmitra and the high regard generally shown to the Jāmadagnyas by the Viśvāmitras, it is more probable that the latter and the other families mentioned above may have followed the example of Jamadagni (X. 110.) in the use of *Tanūnapāt*. The borrowing of verses 8-11 by the Viśvāmitras from the *Āprī* of the Vasiṣṭhas does not go against such a supposition ; for this borrowing can be satisfactorily explained in the following manner.

3. It is now fairly well established that the two Ṛṣis, Vasiṣṭha and Viśvāmitra served as the chief priests at the court of the same king, Sudās (cf. VII. 18 & 83 ; III. 33 & 53). Vasiṣṭha was serving first and was later supplanted by Viśvāmitra. The *Āprī* used by Vasiṣṭha as the Purohit of Sudās, the king of the Bharatas, contains a reference to the tribe of his patron (cf. *bhārati bhārātibhih* at VII. 2.8) and must, therefore, have already been accepted as their favourite *Āprī* by the Sudās-family. Afterwards Viśvāmitra or some other poet of his family composed a separate *Āprī*, but retained the last four

stanzas as a mark of allegiance to the family of Sudās. This conjecture, namely the classification of the *Āprīs* into two distinct groups—the Narāśamsa and the Tanūnapāt—is rendered more probable by a passage in Kātya. Sarvānukra. according to which those *Āpri* hymns which contain an invocation to Narāśamsa are called *Āpram* or rather *Āpram* is the *Devatā* of them, whereas those in which Tanūnapāt is invoked are styled *Āpriyah*. *Āpram* appears to be a collective name and suggests, therefore, that with Narāśamsa the other deities of the *Āpri* hymns formed a perfect unity, but not so with Tanūnapāt, and hence the use of the plural, i.e. the *Āprīs* in the second case.

4. One more point favourable to this conjecture is the identity of Narāśamsa with the Avestic *Nairyosanha*. On the strength of this identity vedic scholars trace Narāśamsa to the Indo-Irānian period. Tanūnapāt, on the other hand, is comparatively a new word and does not occur outside the *Āpri* hymns except at III. 29. 11 & X. 92.2, while Narāśamsa occurs in about 8 passages outside the *Āprīs*. The comparison of the *Āprīs* of Vasistha and Viśvāmitra would support the conjecture that the former is the earlier of the two. For instance at III. 4.3, Agni is called the *hotā* of *id* or *idā* [cf. *ilah hofāram*]. The word *id* has no connection with √*id* 'to praise' which is the key-word at this place in all other *Āprīs*. Possibly the author of this hymn is either misled by similarity of sound or has purposely made an innovation as against the use of √*id* in Vasistha's *Āpri*. Besides Viśvāmitra's *Āpri* does not mention the word '*dvārah*' in verse 6 and has retained, as shown above, the last four verses of Vasistha's *Āpri*. The Agni hymns in Viśvāmitra mandala represent a much later stage of development of the sacrificial ritual. cf. Nos. 8 & 21 in particular.

5. What has been said above of Viśvāmitra's *Āpri* can with equal force apply to the remaining 7 *Āpri* hymns; for in point of their diction and style they approach the ordinary suktas. The nearer an *Āpri* hymn is to the ordinary style, the later it is. Of these 8 later *Āpri* hymns, the *Āpri* of Jamadagni seems to have been considered as the most important one from oldest times. That is why Āśvalāyana lays down that the *Āpri* of Jamadagni may be employed by any one of the Ṛṣi families excepting those of Vasistha and Śunaka. This is further borne out by the fact that Jamadagni is a very old Ṛṣi whom even Vasistha respectfully refers to at VII. 96.3 and Kutsa as well who at IX 97.51 [*ārṣeyam Jamadagnivat nah*] aspires for Ṛṣihood in the manner of Jamadagni. The relations between the families of Jamadagni and Viśvāmitra are, on the other hand, very peculiar. The former are not only respected as an old family of sages by the latter, but are also looked upon by them as their friends and defenders in times of difficulties. It is with the help of the *Sasarparīs* (for the

identification, cf. Velankar, Hymns to Indra B. U. J., Vol. III, part VI) granted to the Viśvāmitras by the Jāmadagnyas that they *i.e.* the Viśvāmitras recovered their position from the ignoble defeat at the court of the king, Sudās (c.f. III 53. 15-16). The importance attached to the song of Jamadagni by the Viśvāmitras in the invocation of Mitra and Varuna at III 62.18, leads to the same conclusion. In the light of this discussion regarding the high position which the family of Jamadagni occupies among the families of Ṛ̥si, it is now not difficult to understand Āśvalāyana's statement that in the Prājāpatya Yāga all should employ Jamadagni's *Āprī*. cf. Asv. Śr. Sūtra. III. 2 [*prājāpatye tu Jāmadagnyah Sarveṣām*].

6. After this discussion on the statement of Āśvalāyana two things relating to the structure of these *Āprī*s deserve notice. (1) All the verses in the different *Āprī* hymns are generally composed in the same metre. Gāyatrī, for instance, is used for I. 13; 188; V. 5; Triṣṭubh for II. 3 (with the exception of verse 7 which is in Jagatī) & for III. 4; VII. 2; X-70; X-110; Anuṣṭubh for I-142; and lastly in IX. 5, the first 7 verses are in Gāyatrī and the last four are in Anuṣṭubh. On account of the diversity of metres used in two *Āprī* hymns just now pointed above (cf. IX-5 & II. 3), and the identical appearance of four ṛks (8-11) in the *Āprī* hymns of the Vasiṣṭhas and the Viśvāmitras, Bergaigne conjectures that some of the Ṛ̥si families had only seven prayājas. Oldenberg does not support this conjecture (vedic hymns part II. p. 9). Bergaigne's point of view would, however, have been strengthened if the Gṛtsamada hymns were to follow a uniform practice with regard to a change of metre in the concluding verse of a hymn. No doubt there are some hymns in the II Maṇḍal, in which there is a change of metre in the concluding verses (cf. II. 8.6; 13.13; 17-8 & 9; 21.6) but there are other hymns also in which the metre changes in some intermediate verses only (cf. II. 23-15 & 19; 24-12). (2) Each *Āprī* hymn contains 11 ṛks, but this general practice is not observed in I. 13 & 142 of which the former contains 12 ṛks since both Narāśansa and Tanūnapāt are invoked, and the latter has got 13 ṛks, Indra also in addition to Tanūnapāt being invoked at the end. Obviously these are later *Āprī* hymns as has already been pointed out above.

7. Closely connected with the question of the relation of these *Āprī*s to different Ṛ̥si families is another question concerning their use and origin. Almost all vedic scholars with the exception of Grassman seem to think that the *Āprī*s were intended to be litanies at an animal sacrifice which was offered up either by itself or in connection with the Soma sacrifice. References to *Vanaspati*, at the 10th place in all the *Āprī* hymns, which is none other than the sacrificial post to which the

victim was tied, and to the *ruśanā* (cf. X.70-10) with which the victim was tied to the post, and lastly to the *Śamitā*, the cutter of the victim (cf. II. 3.10 ; X. 110-10), make it abundantly clear that these *Āprīs* were intimately connected with an animal sacrifice. Even later practice, as reflected in the later vedic Literature, confirms this view ; for according to VS. XX. 36-46 ; XXI. 29-40 ; XXVII. 11-22 ; XXVIII. 24-34 ; XXIX. 25-36 ; Ait Br. II. 1.4 ; Sat. Br. III. 8.1.2 ; VI. 2.1.28 ; XII. 8.2.19 ; Āśv. Śr. Sūtra. III. 2, these *Āprīs* were used at an animal sacrifice. Grassman (Uber. Vol. I. p. 6) is, however, of opinion that the *Āpri* sūktas were not originally intended for use at an animal sacrifice, but formed a liturgical introduction to an Agni sacrifice of a fairly stereotyped form in which *Ghṛta* was the offering. From this point of view he tries to explain the regular scheme for an *Āpri* hymn in the following manner :—

(1st ṛk) Agni is kindled early in the morning. (2 & 3) To him, the self-born (Tanūnapāt), the Narāśamsa, homage is paid. (4) Then *Barhih* is spread. (5) The symbolical-doors of the sacred place are opened to let the Gods with their gifts in. (6) Then special deities are invoked, Night and Dawn being the first. (7) The two divine Hotṛs appear. (8) Then follow the three Goddesses, Sarasvatī, Ilā and Bhārati. (9) Also Tvaṣṭ, the father of the embryo, the protector of the family and cattle is invoked. (10) The trunk of the sacrificial post is anointed thrice with ghee and is raised up (the *pāśu* is let loose). (11) Agni then consumes the trunk and carries the offering to the Gods under blessings of *svāhā*.

8. Haug, on the other hand, believes that these *Āprīs* are nothing but a poetical development of the more ancient prayājas and anuyājas, and owing to their litany-like character are presumably very old blessings which go back to the Indo-Irānian period (Haug Ait. Br. Trans. p. 81). In this connection it is interesting to compare the text of the *Āpri* hymns with the corresponding praiṣas of the Maitrāvaruṇa priest at the Prayāja invocations given at Taitt. Br. III. 6.2. In Avesta there are some short texts or prayers called the '*Afringans*' which are to be recited over a meal consisting of wine, milk and bread offered to an angel or the spirit of a deceased person. These *Afringans* offer a very close parallel to our *Āprīs* (Haug Essays pp. 224-225). In both the terms the root is practically the same ā+√pri 'to please' (Sk.) and √āfri 'to invite' (Avesta). The animal sacrifices of the Indo-Irānians must, indeed, have been accompanied by the predecessors of the later *Āprīs* and *Afringan* invocations, but partly through the reformist tendency and the ethical character of the teachings of Zarathushtra and partly owing to the antagonistic attitude of the ancient Irānians towards the vedic Indians,

the animal sacrifice came to be held in great disfavour among the Gāthīc Irānians with the result that the common invocations—the predecessors of the *Āprīs* and the *Afringans*—came to be employed by them at the ordinary sacrifice as said above. The Vedic Aryans on the other hand, continued their older practice and employed the *Āprīs* at an animal sacrifice.

TRANSLATION.

I. 13.

(1) Being well kindled, O Agni, *Hotṛ*, purifier, bring us hither the Gods for (the man) who offers sacrificial food, and perform the sacrifice. (2) *Tanūnapāt*! Make our sacrifice sweet to-day for the Gods to feast. (3) I invoke here at this sacrifice the beloved *Narāśamsa*, sweet-tongued preparer of (our) oblations. (4) O Agni! Being praised (by us), bring the Gods hither in your easy-moving car. You are the *Hotā* instituted by manus (man or Manu). (5) Strew, O you wise men, in due order [*ānuṣak*] the sacrificial grass dripping with ghee [*ghṛtapaṣṭam*] where the immortal appear. (6) May the divine Doors, promoters of *Ṛta*, inexhaustible, open for worshipping gods this day and at this hour [*nūnam*.]. (7) I invoke at this sacrifice Night and Dawn, the beautifully adorned, that they may sit on this our sacrificial grass. (8) I invoke these two divine *Hotṛs*, the wise ones with sweet tongue.

NOTES.

I.13.

Gāyatri. (1) The key-word of the 1st rk is *sam*+√*iṣh*. In 7 out of 10 *Āpri* hymns *samidha* is used as an epithet of Agni (of I. 13; 142; 188; II. 3; V. 5; IX. 5; X. 110) while in the remaining three *samudh*, a verbal noun, in the sense of fuel is used (cf. III. 4; VII. 2; X. 70). (2&3) For the use of *Narāśamsa* and *Tanūnapāt* in the *Āpri* hymns, see Introduction. Agni is addressed as *Tanūnapāt* 'son of the body' because Agni is enkindled by Agni himself. of I. 12.6. *Narāśamsa*, identical with the Avestic *Nairyosanha* 'praised by men' can appropriately be an epithet of Agni. The function of both *Narāśamsa* and *Tanūnapāt* is to spread out ghee or honey over the sacrifice. (4) The key-word is √*iṣ* 'to praise'. (5) *Ānuṣak*: Adv. from *anu*+√*sanj*. *c*:—*Amṛtasya*: The word may either be mas. or neu.; in the former case it may refer to Agni himself, while in the latter it may stand for all Gods collectively or perhaps for the oblation. cf. *Amṛtasya Celanam* at RV. I. 170.4; *Amṛtasya cakṣaṇam* at AV. V. 4.3; 28.7; XIX. 39.6-8. (6) *Asaścatah*: From √*śac* means 'inexhaustible' acc. to Geldner (Der Ṛgveda Über. p. 12); but it may also be more appropriately taken to mean 'not clinging together' i. e. wide open. (8) *Devyā Hotārau*: They are often called *Prathamā* (cf. I. 188.7; II. 3.7; X. 110.7). Acc. to Geldner they are the first human priest and his sacrificial fire. Acc. to Yāska and Sāyana they are the two forms of Agni namely the terrestrial one and the one in the mid-region [*ayamcāgnih madhyamaśca*]. Oldenberg takes them as the divine counterparts of the *Hotṛ* and his assistant *Maitravaruṇa* priest. It is, however, more likely that the

May they perform this our sacrifice. (9) May *Ilā*, *Sarasvatī*, the great one, the three pleasure-giving Goddesses who never fail (us), sit down on the sacrificial grass. (10) Hither I invoke *Tvaṣṭr*, the foremost, of manifold forms. May he be ours alone. (11) O *Vanaspati* divine, present the oblations to the Gods. May the fame [*cetanum*] of the giver be foremost. (12) Offer the sacrifice with *Svāhā* to Indra in the sacrificer's house. There I invoke the Gods.

I. 142.

(1) Being kindled, Agni, bring to-day the Gods for the man who holds the ladle. Spin out the ancient thread (of sacrifice) for the sacrificer who has pressed out Soma. (2) Measure out, O *Tanūnapāt*, the sacrifice, rich in ghee and full of sweetness, of a priest such as I am who sacrifices and toils for you. (3) The bright, purifying, wonderful *Narāśamsa*, the God adorable among the Gods, sprinkles the sacrifice with honey thrice a day. (4) O Agni ! Being besought (by us), bring hither the wonderful beloved Indra ; for this my prayer, O sweet of tongue, goes up [*vacyate*] to you. (5) (The priests are)

two chief priests known to the oldest ritual were the Hotr and the Adhvaryu (cf. M. Haug Ait. Br. Intro. p. 17). The divine counterparts of these two are *Dvayā Hotārau* in the Āpri hymns. That by these the human priests alone are probably meant is suggested by epithets such as *vīprā* at VII 2·7 ; *puruṣiṭā ṛtvijā* at X. 70·7 ; *Kāru* at X. 110·7. (9) The rk is the same as V. 5·8. Out of the three deities figuring in the Āpri hymns *Bhārati* is dropped here and *Mahī* is mentioned instead as a substitute acc. to some scholars ; this word i. e. *Mahī* also occurs at I. 142·9 & IX. 5·8. Pischel (ved. studien. II 84 seq) does not favour this idea, but proposes *Mahī* as a name of the Goddess, *Dhīṣaṇā*, whereas M. Müller takes it as a river of that name. It should, however, be treated as an adjective of any one of the three Goddesses according to the context. It should be remembered that the word occurs at I. 142·9, and II. 5·8, in addition to the usual three deities (*Tisro Devatā* i. e. *Ilā*, *Bhārati* and *Sarasvatī*) thus showing that it is conceived as an adjective. (11) *Dātih* : Bergaigne changes the accent of the word (*dātih*=*dātuh*) in view of V. 7·7, deriving it from √ *dā* ' to cut ', and understands by it the human cutter of the victim. Oldenberg (Noten Vol. I.p. 14) is prepared to take it in the sense of the divine cutter of the victim namely Agni himself (cf. III 3·4) if at all the word is to be derived and accepted as Bergaigne does. He, however, is in favour of retaining the traditional accent of the word, taking it as referring to either Agni as the giver (√ *dā* ' to give ') of the rewards or to the human sacrificer as the giver of oblations.

I. 142.

Anuṣṭubh. (1) *Tantu* : It here stands for the continuity of the sacrificial institution (cf. I. 159·4 ; II 3·6 ; X 57·2 ; 130·1 ; also √ *tan* used in connection with the sacrifice.) (2) *Śaśamāna* : To be derived from √ *śam* ' to labour. ' (4) *Vacyate* (=ucyate) : Acc. to Oldenberg *ucyate* is not used here as in similar passages like III 39·1, & X 47·7, to avoid the hiatus caused by a preceding vowel but √ *vac* is used in the sense of ' move forward ' in such a context (cf. I. 46·3 ; III 6 1 ; 39·1.). (5) *Śiṣṇānāsah Vṛnje* : An example of Anākoluthon. The poet

strewing the sacrificial grass and holding the ladle up, at this well-prepared sacrifice. For Indra I trim (the sacrificial grass), a wide shelter most spacious to receive the Gods. (6) May the divine Doors, the promoters of *Rta*, the wide, purifying, much desired, unfailing ones, open themselves for the Gods to enter. (7) May Night and Dawn being lauded, the neighbouring (Goddesses) of fine appearance, the young mothers of *Rta*, sit together [*sumat*] on the sacrificial grass. (8) May the two divine *Hotṛs*, of sweet voice, uttering prayers, the wise ones, perform this our sacrifice, which is successful [*sidhram*] and reaches Heaven to-day. (9) May the bright *Hotra Bhārafi*, placed among the Gods, the Maruts, (so also) *Iṭā*, the great *Sarasvati*, the adorable ones, sit on the sacrificial grass. (10) May *Tvaṣṭṛ*, well disposed towards us, let loose by himself that wonderful abundant seed in our navel, for the sake of prosperity and wealth. (11) Setting free (the victim) by yourself, O *Vanaspati*, sacrifice to the Gods. Agni, the wise God among the Gods, makes the offerings ready. (12) For Indra who is accompanied by Puśan and by the Maruts and is inspired by the Gāyatra song, for the Viśve-devas and for Vāyu, offer the oblations with *Svāhā*. (13) Indra! Come here for a feast to the oblations sanctified with *Svāhā*. Do come! Hear our call! They invoke you at the sacrifice.

gives up his first construction where he conceives the priests as the subject, when he comes to *vṛṇje*. Oldenberg proposes *vṛṇje* as 1st per. at S. B. E. 46-155, but at *R̥gveda* Noten Vol. I p. 144 takes it as passively used in the 3rd per with *barhih* as the subject (cf. VI. 11-5 and VII. 39-2) On the use of \sqrt{vrj} with *barhih*, see Oldenberg. Vedic hymns Part I 1-38-1. (1) *Bhandamāne*: To be derived from \sqrt{bhand} I. A. 'to receive praise' (cf. III 2-12 and 4-6). Oldenberg takes the root to mean 'to shine forth' and Grassmann derives *bhadra* from it. *Sūnat*: Geldner takes it as an adjective of *barhih*, meaning 'beautiful (soft)' (*Ved-studien* II 190). Acc. to Oldenberg it means 'together' which seems better (cf. V. 2-4; X 32-3). (8) For *Hotārau daivya* see note on I 13-8; *Jugurvaṇī*: From the $\sqrt{jṛ}$ I. A. =gr, 'to praise', meaning 'uttering praises'; it occurs only here. (9) *Mahī*; See note on I 13-9. C:—The conjecture for reading *marṭeṣu* in place of *marutsu* appears bold to Oldenberg as it is against the text. (10) *Puru vāram*: Grassmann reads it as one word *Puruvāram*: See Oldenberg Vedic Hymns Part II p. 156 (cf. II 40-4). At Noten Vol. I p. 145, however, Oldenberg rightly points out that there is no definite ground for this assumption. Geldner, however, takes *puruvāram* as one word in the sense of *bahuvāram* 'frequently' Padapāṭha separates as *vā aram* (cf. VI. 13-4; VII 7-6).

Tmanā: Oldenberg takes it with *puru* 'plentiful by itself'. It should rather go with *Tvaṣṭṛ* as in the following rk [*uṣa tmanā dṛvan yaḥṣi vanaspatē*] and also at I. 188-10 [*uṣa tmanyā vanaspatē*]. (11) *Vanaspati* is none other than the sacrificial post to which the victim was tied. (12) *Gāyatra-vepase*: *Vēpas* is to be derived from \sqrt{vcp} . It is rather strange that Indra is said to be moved by Gāyatra songs which are generally the favourite songs of Agni (*Gāyatravepas* as an adjective of Indra occurs also at VIII. 1-10); but the word *Gāyatra* may have been used in the general sense of a 'song' (cf. I. 10-1).

I. 188.

(1) Being kindled you rule to day, a God with the Gods, O winner of thousands! Carry our oblations as a messenger, a sage (as you are). (2) O *Tanūnapāt*! The sacrifice is seasoned with honey for the pious sacrificer [*ṛtam yate*]. May he (i.e. *Tanūnapāt*) grant thousand-fold food. (3) Invoked and fit to be praised, bring hither. to us the worshipful Gods. Agni! You are a winner of thousands. (4) They have spread with might the sacrificial grass pointing to the east, to seat a thousand heroes (i.e. Gods), whereon you preside, O *Ādityas*! (5) The princely, the sovereign, the all-pervading, the eminent, the spacious and manifold, the (divine) Doors have poured forth (streams of) ghee. (6) Adorned with gold and well decorated, you indeed shine in your glory. Sit down, O Night and Dawn! (7) (They) are verily the first two Hotṛs, divine and eloquent sages. May they perform this our sacrifice. (8) *Bhārati*! *Ilū*! *Sarasvatī*! All you (Goddesses) whom I invoke, lead us on to glory. (9) *Tvaṣṭṛ* indeed, the Lord, has shaped all forms and all cattle. Grant us their abundance. (10) Send the sacrificial food to the Gods by yourself, O *Vanaspati*! May Agni make the oblations delicious. (11) Agni, the fore-runner of Gods, is anointed (with ghee) to the accompaniment of the *Gāyatra* song. He shines at offerings blest with *Svīhā*.

I. 188.

Gāyatrī. This hymn seems to be closely related to X. 110. Oldenberg thinks (S. B. E. 46, 188) that the author of X. 110, knew and imitated this hymn. (2) *c.—dadhat*: Either present participle going with *yajna* or Inj. 3rd per. sing. going with *Tanūnapāt* to be supplied as the subject; but the latter seems to be better in view of II. 9-1; IV. 24-7; V. 14-1; and also the fact that Agni (and not *yajna*) is associated with the 'winning of thousandfold riches' in the preceding and the following rks where $\sqrt{sā}$ and $\sqrt{jī}$ are equal to our $\sqrt{dhā}$ in this passage (3) *Ājuvānah ṛdyah*: Repeated at X. 110-3. (4) *Sahasravīram*: acc. to Oldenberg 'this is the Daśavīra sacrifice of the śāktyas. Ten valiant sons are born to those who perform it' (Pancavimśa Br. XXV. 7-4). But the word *vīra* may even be taken to refer to the Gods and *Sahasravīram* may then mean 'making room for a thousand heroes i.e. Gods.' *Vīra* is often used for Indra, Maruts and other Gods (cf. I. 30-5; 61-4; 85-1; IV. 25-6) and *barhiḥ* is called as *dvavayacastanam*. (5) *a*: *Vīrūt* and *Samvūt* occurring in the singular are perhaps proper names of the sacrificial doors as happily suggested by Oldenberg and Geldner, (6) *Usāsau*: *Ekaśeṣa dvandva* 'Dawn and Night'. (7) See note on I. 13-8. (9) \tilde{a} + \sqrt{yaj} is sometimes used in the sense of 'to grant'. (10) *Pāṭhah*: Acc. to European scholars it always means 'a place' in R̥gveda, but Sāyana who takes it in the sense of 'food' (from $\sqrt{pā}$ 'to drink') may be right so far as our passage and III. 31-6. are concerned. (cf. Velankar: Hymns to Indra, B. U. J. Vol. III. Part VI. p. 8-9). (11) *Samajyase*: Passive of $\sqrt{āñj}$ 'to anoint'; it may also be taken as a passive form of \sqrt{aj} 'to urge' (cf. II. 39-7; VI. 25-9)

II. 3.

(1) Agni, being kindled and set down on the earth, has stood up facing all the worlds. May the divine *Hotṛ* form of old, the purifier, the wise God Agni, being worthy, sacrifice to the Gods. (2) *Narāśamsa* lighting up the sacrificial chambers, equal to the three worlds by his greatness, of great splendour, moistening the offering with a mind intent on pouring ghee—may he anoint the Gods at the head of Sacrifice. (3) O Agni ! Being praised in our mind as the worthy one, sacrifice for us to the Gods before the human sacrificer. Bring hither the host of Maruts. Sacrifice, O men, Indra who is never foiled and is sitting on the sacrificial grass. (4) O divine *Barhih* ! On this (*Barhih*) which is increasing, rich in heroes, easily spread on the *Vedi* for wealth, anointed with ghee, take your seat, O Vasus, O all Gods, O *Ādityas*, worthy of worship ! (5) May the divine doors, easily passable, invoked with worship, open wide. May they, the spacious ones, undecaying, open wide, consecrating the race famous and rich in men. (6) May Dawn and Night, grown strong from of old, joyful like two female weavers, (do) their work well for us—they who combining together weave the woof spread out, the pattern of the

II. 3.

Tristubh, 7 jagatī. (1) *Pāvaka* : *Pavāka* is everywhere to be restored (Arnold. VM. p. 143). *Pradivah* : Adv. 'from old days'. *Arhan* : Compare the later use of the word among the Jains and the Buddhists (2) *Dhāmāni* : *Dhāman* from √ *dhā* 'to place' or 'to support', meaning (1) abode cf. II. 3.11 [*Ghṛtamvasya dhāma*]; III. 55-10 [*viśvā dhāmāni*], (2) Law or practice, of III. 7.6 [*anusvam dhāmu jarituh vavakṣa*]. (3) Power or lustre cf. X. 166.4 [*abhibhāt* *dhāmānā*]. c:—The meaning is metaphorical, the *manah* standing for the ladle in the hands of *Narāśamsa* conceived as the *Hotṛ*. *Mardhan yajnyasya* naturally refers to the *vādi*. The role attributed to *Narāśamsa* here is the same as that assigned to *Tanūnapāt* elsewhere; thus the identity between the two is established. (3) *Mānusāt pūrvah* : Agni is Arch-sacrificer. cf. X. 53.1 [*pūrvah asmāt*]. *Barhiṣadam* : Oldenberg proposes to change it to *barhiṣṣadam* : Waekernagel (Vol. I. p. 342 and Vol. II. p. 125) takes it to be a vedic custom by which the ending 's' of the first member in a compound is dropped, he calls it vedic elision. Acc. to Arnold (VM. p. 143) *barhiṣadam* is preferable here and in V. 44.16; but *barhiṣṣad* in VII. 2.6c; IX. 68, 1c; X. 15.3c. (4) *Subharam vadyasyām* : 'Easily carried on the altar or well laid upon the altar'. *Viśve devāḥ* : If it is to be taken as one word as Oldenberg would have it, both *viśve devāḥ* and *Ādityāḥ* being vocatives would have to be accented; but the latter is not so accented. The difficulty can be solved if *viśve* be taken as a separate word in the nominative, an adjective of *devāḥ* and *Ādityāḥ* of VII. 51.3 [*Ādityā viśve Marutaśca Viśve*]; also III. 14.4 [*viśve marutah*]. (5) Arnold (VM. p. 142) reads *urviyā* for *urviyā* and *suprayānāḥ* for *suprāyānāḥ* 'easily passable'; acc. to Oldenberg also *suprayānāḥ* is supported by forms like *suprayā* (cf. VII. 39.2), *prayai* (cf. I. 142.6) and other corresponding passages of the *Āpṛi* hymns. *Varṇa* : A race or a community, (cf. I. 104.2 and III. 34.9.) (6) A happy comparison between Night and Dawn on the one hand and two female weavers on the other, a:—After *apāmsi* some form of

sacrifice, they easy to milk, rich in milk. (7) May the two divine *Hotrs*, the first ones, the very wise, the very beautiful, rightly sacrifice together with *ṛks*. They sacrificing together to the Gods, at the proper season, anoint them, on the navel of the Earth, over the three sloper. (8) *Sarasvatī*, the accomplisher of our prayer, the Goddess *Ilā*, the all-surpassing *Bhārati*—may all the three Goddesses, of their own accord, sit down on this *Barhih*, the faultless shelter, and protect (us). (9) Swiftly a manly son is born, tawny in colour, well supporting (*Subharah*), bestower of strength, loving the Gods. May *Tvaṣṭr* loosen the navel for us, and may he (*Virah* or *havih*) go to the abode of the Gods. (10) May the vanaspati rise up, releasing (the sacrificial food.) May Agni make the offering ready with his skill (*Dhibhih*). May the knowing divine Immolator carry the thrice-anointed offering to the Gods. (11) Ghee is sprinkled. His womb is ghee. He rests on ghee. His abode is ghee. Bring (the Gods) according to your wont. Rejoice, carry the oblation consecrated with *Svāhā*, O Bull !

✓ *hṛ* is to be supplied; *Sanatā*:—Adv. 'From times immemorial'; Weber proposes *sanatām*. Genitive plu. from ✓ *san* 'to win', but Oldenberg does not approve of it. *b*:—*Vayyeva* occurs only here. It is, therefore, difficult to decide what exactly it means. It may be *vayye iva* (dual Fem.) or *vayyā iva* (dual Mas. or Sing. Fem. like *uśāsānahā sutughā iva dhenuh* at VII. 2-6); Padapāṭha reads *vayyā iva*. The word *vayyā* means 'a female companion'; Oldenberg suggests its derivation from *vi* 'a bird'. Can we not derive it from *vayah* 'age' (cf. the classical *vayasya*)? *cd*:—'Coming together they weave the woof spread out, the pattern of the sacrifice'. The idea is common in R̥gveda, also cf. VS. 20-41 [*tantum tatam pśasā saṇvayanā*]; acc. to Geldner 'They weave the *tantu* (of time) and the *pśah* (of the sacrifice)'. Perhaps *tantu* and *pśah* may stand in apposition; for *yajñasya pśah* cf. VII. 42-1 [*adhavarasya pśah*] Oldenberg takes *pśah* to mean 'an ornament' and Pischel takes it along with Sāyana to mean '*rupa*' i.e. form'. (7) *Nābhā pṛthivyāh*: Acc. to Oldenberg, 'at the official sacrifice' or 'at the altar' as Sāyana takes it. The three *sānus* are probably the raised places where the three śrauta fires are enkindled. (8) *Viśvatuṛtiḥ*: 'All-surpassing' from ✓ *tvar* or ✓ *tṛ*; *svadhayā* means 'of their own accord' from *svadhā* 'inherent power'. *Acchidram śaraṇam*: 'A safe or secure refuge' either Nom. or Accu. sing; in the former case it becomes the standard of comparison for the *Devīh* and we get *Luptopamā* acc. to Geldner, 'Let the three Goddesses protect this *barhih*, having sat down, as a safe refuge (protects)'; in the latter case two more interpretations are possible according as *barhih* being taken as an object of *pāntu* and *śaraṇam* going with *niśadya* or as *barhih* going with *niśadya* and *śaraṇam* being taken as an object of *pāntu*. (9) *Subharah*: 'easy burden'; a good son supports himself. Acc. to Sāyana the word means 'well grown' and acc. to Oldenberg, 'rich in gain'. *d*:—The subject of *etu* is either *virah* or the sacrificial offering mentioned as the object of *ava*+✓ *spj* in the next rk. For *pāthah* see note on I. 188. 10. (10) *Samitā*: 'The slaughterer' who cuts up the victim (of I. 162. 9-10). Agni plays the roll of the *samitā* metaphorically (of. RV. III. 4.10; X. 110.10; VS. 21-21; 28.10); on this aspect of Agni see introduction para 7. (11) *Mimikse*: Either Passive or Active 3rd per sing.

III. 4.

(1) At every log of fuel be kind towards us. With every flash you grant us the¹ vasu's favour. Bring hither the Gods, O God, for sacrifice. Being well disposed, O Agni, sacrifice as a friend to your friends. (2) (*Tanūnapāt*) whom the Gods, Varuṇa, Mitra, Agni, honour daily thrice a day, O *Tanūnapāt*, make this our sacrifice which worships (the Gods) and whose abode is in ghee, sweet with honey. (3) (Our) thought rich in all boons goes up to worship the first *Hotṛ* of the holy food and to honour him, the Bull, with prayers. May he, the best sacrificer, inspired (by our prayers) sacrifice to the Gods. (4) Your way to the sacrifice is made to go high up ; the flames have gone up to the (high) regions. Or the *Hotṛ* has sat down at Heaven's navel. We spread out the sacrificial grass, spacious enough to receive the Gods. (5) Choosing in mind the work of seven priests, inspiring all, (the Gods) came according to the Holy Law. (The divine doors) many and adorned with heroes (i. e. Gods or men), born at the sacrifices, have moved on here to this sacrifice. (6) Hither (come) the two Dawns, the neighbourly ones, being lauded and differing in form, they smile on so that (the Gods) Mitra, Varuṇa, Indra accompanied by Maruts, with their glories, may accept us. (7) I propitiate (*Nyr̥iḥje*) the two *Hotṛs*, the first

III 4.

Tristubh. (1) *Sumatim vasuḥ*: 'Vasu's favour or grace' (cf. VII. 39-1). (2) On *Tanūnapāt* see note on I. 13-2; Visvāmitra tells us that both *Narāśamsa* and *Tanūnapāt* are two forms of Agni (cf. III 29-11). (3) The key-word is √*id̐*. Agni is honoured with epithets such as *īdītah*, *īdyah* or *īlenyah* in 8 out of 10 *Āpri* hymns; in one i. e. X 70-2 [*agnim īlate*] he is made the object of √*id̐*, whereas here he is the *Hotā* of *idā* or *īdā*. There seems to be a confusion on the part of the composer of this hymn in so far as in place of √*id̐* generally used in all other *Āpri* hymns he has put *id̐* or *idā* 'sacrificial food' which has no connection with √*id̐* 'to praise'. He seems to be misled by similarity of sound; for *hotāram īlah* cf. I. 128-1; II. 10 i; VI. 1-2; X. 91-1. (4) *Barhih* which is spread around the *vedī* for the Gods to sit upon is called *devaryacāh* 'roomy or spacious for Gods'. *Vām*: Acc. to Sāyana *Agni* and *Barhih*; acc. to Oldenberg *Āhavanīya* and *Gārhapatya* fires and acc. to Ludwig Heaven and Earth. Sāyana is probably right because Agni as *Hotā* and *Barhih* are the only two directly mentioned in the same rk. (5) In no other *Āpri* hymn is the word *Dvārah* in some form or other dropped. *ab* :—The subject is *devāh* to be supplied. *Sapta hotram* means 'the work of the seven priests'. *al* :—The subject of *vicaranta* is *Dvārah* supplied acc. to Sāyana and Oldenberg while Grassmann, Geldner and Ludwig take *devāh* as the subject and *pūrvāh* (i. e. *Dvārah*) as the object of *vicaranta* and translate 'The Gods come to the sacrifice through the many doors etc'; for *pūrvāh* (Fem. of *puru* 'many') as standing for doors cf. I. 188-5; VII. 2-5. (6) Uṣasā: 'Night and Dawn'; the word occurs here and at I. 188-6. *Uṣāke*: From *upa* + √*ān̐*, adj. 'neighbourly' or adv 'before us' acc. to Grassmann (cf. *parāke*, *sam̐ke*, *abhike* and *prad̐ike* etc.). (7) On *daiṇyā hotārau* see note on I. 13-8. *Sapta pṛkṣāsah*: 'Steeds' acc. to Grassmann; Pischel takes the seven strong ones' to stand for the seven early ancestors

ones. The seven strong ones rejoice at will. Praising the truth, they speak the truth, the guardians of Law, contemplating according to Law. (8) May *Bhāratī* with the *Bhāratīs*, *Ilā* with the Gods, Agni with mortals, *Sarasvatī* with the *Sārasvatas* (come) here. May the three Goddesses sit on this sacrificial grass. (9) O God *Tvaṣṭr*, liberal, send forth that seed (*Turīpam*) which is to grow and from which is born a heroic son, skilful, capable, adjuster of the press-stones, loving the Gods. (10) O *Vanaspati* ! Send forth the oblation to the Gods. May Agni, the Immolator, dress it. May he, the truer *Hotr*, sacrifice as he knows the generations of the Gods. (11) Being kindled, O Agni, come here in the same chariot with Indra and swift (*Turebhīh*) Gods. May *Aditi*, the mother of good sons, sit on our sacrificial grass. With *Svāhā* may the immortal ones (i. e. Gods) rejoice.

V. 5.

(1) Offer hot ghee to Agni, *Jātavedas*, the well-kindled flame. (2) May the undeceived *Narāśamsa* make this sacrifice ready; for he is a sage with sweets in his hand. (3) Being praised (by us), O Agni, bring hear for our help the wonderful, beloved Indra on easy-going chariots. (4) O the bright (*Barhīh*), soft as wool spread yourself. The hymns have been sung (for you). Lead us to success. (5) O divine Doors ! Easy of access, open yourselves for our protection. Fill the sacrifice more and more. (6) We implore Night & Dawn of lovely mien, the two young mothers of *Ṛta*, who increase our vital power. (7) Being praised (by us), O two divine *Hotṛs*

generally referred to as *sapta viprāh* at III. 7-7; 31-5; IV. 2-15; VI. 22-2; they are evidently the *Aṅgirasas* (cf. Velankar B. U. J. Vol. III part 6 p. 8), (8) *Ṛks* 8-11 are the same as VII. 2. 8-11 (see Introduction para. 3). The celestial followers of the three Goddesses. *Ilā*, *Sarasvatī* and *Bhāratī* are mentioned only in the *Āprī* hymn of the *Vasiṣṭhas* and in this hymn (Intro. para 3). *Ilā* is the personification of all kinds of food especially those obtained from a cow. That is why she is many a time identified with a cow in *Śrauta sūtras*. In the *Brāhmaṇas* she is represented as a woman, the daughter of Manu, with her feet dripping with ghee. *Bhāratī* seems to be the personified offering of the *Bhāratas* (cf. *Bhāratī hotṛā* at I. 142-9; II. 1-11; III. 62-3). *Sarasvatī* is the deified river of that name on whose banks sacrifices were performed. (cf. III. 23-4). In fact her banks were the cradle of *Brāhmin* culture and civilisation. These three Goddesses together, indeed, stand for everything of vital importance to the vedic civilisation, and are, therefore, rightly associated in the *Āprī* hymns of the two *Ṛṣi* families. (9) *Ravāṇah* : 'Delighted' from √ *raṇ* 'to rejoice', or 'liberal' from √ *ra* 'to give'. (10) *Samīṭā* : See note II. 3-10. (11) *Tura* : 'Swift or mighty' (cf. VII. 86-4); the word is either derived from √ *tvar* (weak form √ *tur*) 'to hasten or from √ *tṛ* (*tar*) 'to cross'

V. 5.

Gāyatri. (1) *Śocih* : 'Flame' from √ *śuc* 'to shine' (cf. *śukra*, *śoka* etc.). (3) *ab* : The same as I. 142. 4 *ab*. (5) *Suprāyaṇā* : See note on II. 3-5.

come here on the wind's wings (*Patman*) to this our sacrifice. (8) May *Ilā*, *Sarasvatī*, the great and (*Bhārati*), the three Goddesses, the bringers of bliss, the never-failing ones, sit on the sacrificial grass. (9) Come hither, O *Tvaṣṭr*, of your own accord, being the auspicious over-Lord of nourishment. Protect us at every sacrifice. (10) Wherever you know, O Lord of the Forest, the secret names (or places) of the Gods, to that place carry these offerings. (11) With *Svāhū* to Agni, Varuṇa, Indra, Maruts and to the Gods, the oblation is offered.

VII. 2

(1) Accept our fuel to-day, O Agni, and shine mightily, sending forth the sacred smoke. Touch the celestial summit with (your) crests. Spread yourself with the rays of the sun. (2) In the midst of those Gods who are most wise, pure, inspirers of our thoughts, and enjoy both kinds of oblations, we praise the greatness of the holy *Narāśamsa* with sacrifices. (3) We will for ever glorify for our sacrifice Agni, enkindled by Manu (or man), fit to be lauded, your skilful *Asura*, a messenger between the two worlds, the truthful speaker. (4) Seeking to serve and carrying *Barhih*, they with bended knees spread it with reverence by the side of Agni. Inviting (Agni) to the spotted grass, sprinkled with ghee, O *Adhvaryu*, anoint him with oblation. (5) With good thoughts, those devoted to the Gods and longing for (their) chariots, have thrown open the doors at the Gods' assembly (i. e. sacrifice). Like the maidens (decorating themselves) at the gatherings they adorn the doors which are like two mother cows

(8) *Mahī* : See note on I. 13-9 with which this rk is identical (10) *Namānū* . It is almost a synonym for *padāni* (cf. I. 164-5; III. 38, 3; X. 5-2).

VII. 2.

Triṣṭubh (1) *d* :- cf. I. 98-1 [*vaiśvānarāh yataṭe sūryaṇa*]. (2) *Eṣām* :- Oldenberg takes it to refer to Gods '*Narāśamsa* of Gods'; Sāyana does the same and supplies *madhye* after it. Grassmann takes it with *mahimānam*. 'May I praise the greatness of Gods through sacrifices to *Narāśamsa*.' *d* :- *Ubhayām havyā* stand for offerings of soma and ghee or butter (Sāyana). (3) *Munusval* . 'Like Manu or like men'. (4) *Saparyu* : 'Seeking to serve' from $\sqrt{\text{sapary}}$, denominative of *sapar* from $\sqrt{\text{sap}}$ 'to serve'. *Abhijnu* = *abhi + jnu* (= *jānu*) ind. 'on the knees' (cf. I. 72-5; III. 39, 5). *d* :- *Marjayadhvam* from $\sqrt{\text{mrj}}$ 'to cleanse or purify' used in connection with Agni when conceived as a horse (cf. VII. 3-5). (5) *ab* :- The subject is *devayantah* i. e. the priests or the *yajamānas*; *rathayuh* = *rathayavah* (Nom. plu.) going with *devayantah* acc. to Sāyana, but it is better to take it as an adjective of *durah* as at X. 70-5 cd. *cd* :- The subject is *devayantah* : *pūrvī* as an object of *samanjan* may be taken as standing for *durah* (cf. *bavhi* at I. 188-5 and *pūrvih* at III. 4-5) or as an adjective of *mātarā* (cf. X. 123-3), but in the latter case *durah* from *a* will have to be supplied as an object of *samanjan*. For the simile of cows licking their younglings (cf. III. 33-1 & 3). Here the *śisu* is obviously the fire enkindled inside the doors of the sacrificial chamber. Sāyana, however, takes *pūrvī* to stand for *jūhupabhytau*

licking their youngling. (6) May Night & Dawn, the two celestial ladies, invoked by many, sitting on the sacrificial grass, wealthy, worthy of worship, come (to our sacrifice) for welfare as a cow easy to milk. (7) You Bards, singers at men's sacrifices, both of you being *Jatavedas*, I think of worshipping you. Send up our sacrifice (to the Gods) at our invocations, and win us treasures among the Gods. (8-11)= III. 4. 8-11.

IX. 5.

(1) *Pavamāna*, the Lord. enkindled, the bellowing Bull, pleasing (the Gods), shines on all sides. (2) *Pavamāna*, the *Tanūnṣpāt*, sharpening his horns, moves shining through the firmament. (3) *Pavamana*, (our) praiseworthy treasure, full of splendour, shines mightily with streams of honey. (4) The tawny *Pavamāna*, God, spreading the sacrificial grass eastward with vigour, goes to the Gods. (5) The golden divine Doors, being glorified by *Pavamāna*, rise up with their panels (i. e. throw them open). (6) *Pavamānu* longs for Night & Dawn of good form, the lofty great ones, like handsome maidens. (7) I invoke the two divine *Hotṛs*, the Gods watching men. *Pavamāna* is *Indu*, the Bull. (8) May the three Goddesses belonging to *Pavamāna*, *Sarasvatī*, *Ilā*, the great & *Bhārati*, well adorned, come to this our sacrifice. (9) I invoke *Tvaṣṭṛ* hither, the first born, the protector, the leader. *Indu*, the *Pavamāna*, the tawny Bull, the Lord of creatures, is *Indra*. (10) O *Pavamāna*! Anoint with honey in a stream the *Vanaspatī* with a thousand branches, green, resplendent and golden in colour. (11) All ye Gods, *Vāyu*, *Surya*, *Br̥haspati*, *Indra*, *Agni*, come together to the offering consecrated with *svāhā*.

'the two ladies' and *agṛivah* to mean 'rivers', 'The ladles are plying the fire with ghee at sacrifices as the mother cows lick the calf or as rivers (water the fields)'. (6) *Dhenuh*: *Dhenu* is suggested, but the use of *dhenuh* in the singular is quite normal in such contexts (cf. I. 186-4b) (8) *Manuṣyabhiḥ agnū*: 'Agni with men i. e. the ancestors such as the *Aṅgirasas*'. (8-11) rks are identical with III. 4.8-11 (see Intro. para. 3).

IX. 5.

1-7 *Gāyatrī*, 8-11 *Anuṣṭubh*. In this hymn *Pavamāna* Soma plays the roll which *Agni* plays in other *Āprī* hymns (5) *Ataiḥ*. 'With panels'. The word occurs in the masculine gender here while in the other three passages it is Fem. [cf. *divah ātāsu* at I. 56-5b & 113, 14; *divah ātāh* at II. 43.6] In all these passages *āta* or *ātā* is associated with *āivah* and means 'ends of Heaven or the doors of Heaven. Grassmann derives it from *a* + \sqrt{ian} or it may be derived from \sqrt{at} 'to go'. (8) *Mahī*: All the three Goddesses are mentioned and this word comes after *Ilā* and is, therefore, to be taken as an adjective of *Ilā* (see note on I. 13-9). (8-11) Arnold (VM. p. 284) considers these rks as later owing to the peculiarity of their metre. Oldenberg, on the other hand, assumes the unity of the hymn. As regards the metrical peculiarity in 8-11 rks, he thinks that these are the characteristics of *Anuṣṭubh* and not of *Gāyatrī* and appear, therefore, in the latter part consisting of *Anuṣṭubh* and not in the former (i. e. 1-7 rks) which is composed in *Gāyatrī*, though the two parts form a unity.

X. 70.

(1) Accept, O Agni, this my fuel. Welcome this ladle full of ghee at the place of oblation. Rise up for the sacrifice to the Gods, O wise Agni, on the elevated plot of the Earth [*varṣman*] when days are pleasant. (2) May Narāśamsa, the fore-runner of the Gods, come hither on horses of various forms along the path of *Ṛta*. May he, the holy and most god-like, respectfully make (our offerings) sweet for the Gods. (3) Men with offerings praise Agni, the most eternal, for the work of a messenger. Bring the Gods hither in a lightly-rolling chariot with draught horses and sit down here as the *Hotṛ*. (4) May (*Burhih*) dear to the Gods spread out transversely. May it be for us long in length and fragrant. O divine *Barhih*! Sacrifice with a friendly spirit to the willing Gods headed by Indra. (5) C Doors! Touch the highest summit of Heaven or open up as wide as the measure of the Earth. Longing and being eager for the chariot, admit the celestial car together with those who are mighty in (their) greatness. (6) May the Goddesses Night & Dawn, the beautiful daughters of Heaven, sit on this altar. O you auspicious and willing ladies! May the Gods willingly take their seat on the wide lap (i. e. the altar). (7) Up stands the pressing stone or mightily is the fire

X. 70.

Triṣṭubh. (1) *Harya*: To be derived from \sqrt{hary} 'to like' or 'to delight in' *Dvayaṣyā* = *devayaṣyāyām* (Pischel), but Oldenberg is right in taking it as an Instrumental form ending in *ā*; of course it has the sense of the Dative. Sāyana takes it as an Instrumental form. (2) *Miyḍhah*. Adj. 'holy'. European scholars, however, change it into *miyḍham* (Grassmann) or take it as a neuter noun ending in *as* (Oldenberg and Geldner) in view of the fact that in the corresponding rks of the other *Āpvi* hymns words like *havyā* (cf. VII. 2.2) and *yajnam* (cf. V. 5.2) associated with \sqrt{sud} , and *havyam* (cf. II. 3.2) appear in such contexts. Perhaps they are right. But Sāyana seems to be justified in taking *miyḍhah* = *miyḍhyah* or *madhyah* in view of I. 26.1; 36.9; 44.5. The form *miyḍhya* which seems to have been regularly pronounced as *miyḍhya* (cf. Oldenberg ZDMG 55 p. 270 ff) was found metrically unsuitable here by the poet and hence he must have used *miyḍhah* (masculine). (5) *Varīyah*: J. Schmidt takes it with *prthivīyāh matrayā* 'wider than the measure of the Earth', but as Oldenberg points out (cf. noten Part II p. 273) the separateness and the parallel construction of *a & b* favour *varīyah* going with *sanu* (cf. *varīyah barhih* in rk 8 below). Oldenberg, Noten, II p. 273, wrongly ascribes the reading *prthivīyā* to the Pada Pāṭha. The mistake is evidently due to misprint in the edition that was before him. Max Müller gives the right reading i. e. *prthivīyāh* in his Index of Padas p. 365 and so does Grassmann in his Woerterbuch P. 857. *cd*:- Geldner (Komm.) suggests an erotic secondary meaning in view of X. 110.5; see also Sāyana on this, but Oldenberg does not agree. *Mahadbh:h*: Oldenberg supplies *ūtaih* after it and compares X. 5.5: Sāyana supplies *devaiḥ* after it. *Rahayuh* = *rahayūh*, an adjective of *dvārah* (cf. VII. 2.5). (6) *Susilpe*: The word may refer to the art of decoration or skill in general. Does the word refer to the art of image-making also? (7) *Dhāmāni*: See note on II. 3.2a. Here the

enkindled. The dear oblations are ready on Aditi's lap (i. e. the altar). O you two chief priests at this our sacrifice, very wise, win for us wealth. (8) O you three Goddesses ! Sit down on this wide grass. For you we have made it comfortable. May the Goddess *Īā*, with her feet dripping with ghee, enjoy along with other Goddesses, as she does from (other) men [*manuṣvaṭ*], the sacrifice and the oblations well placed. (9) Since you have imparted beauty and have been the Angirasa's companion, O God *Tvaṣṭr*, willing, possessed of wealth, bestower of wealth, sacrifice to the abode of Gods, knowing (as you do). O *Vanaspati* ! Knowing well and binding with a cord, take (the oblation) to the abode of Gods. May the God prepare our oblations and make them delicious. May Heaven and Earth favour our invocations. (11) Agni ! Bring here for the sacrifice Varuṇa and Indra from Heaven, the Maruts from the mid-region. May all the Holy ones sit on the sacrificial grass. May the Gods rejoice in *svāhā*.

X. 110.

(1) O God *Jātavedas* ! Being enkindled sacrifice to the Gods in the house of man to-day and, O God, bright as Mitra, knowing them, bring them here. You are, indeed, a wise, and intelligent messenger. (2) Tanūnapāt, of fine tongue, anointing the paths and ways of *Ṛta*, make them pleasant. Take our sacrifice to the Gods, helping our prayers and the sacrifice with (your) holy thoughts. (3) Come along with the Vasus, O Agni, invoked, praised and adored. You are, O active Lord, the Gods' *Hotṛ*. Being a better sacrificer and being implored (by us), sacrifice to them (i. e. Gods). (4) By ordinance the sacred grass is spread eastward for covering this Earth at the break of days. It is spread fairly widely and extensively, comfortable for Gods and Aditi. (5) May the spacious Doors open widely, like wives adorning themselves for their husbands. Divine, lofty, all-inspiring Doors ! Be of easy access to the Gods. (6) May holy Night and Dawn, celestial great ladies with golden ornaments, endowed with radiant beauty, flowing (i. e. spreading), sit down closely together on

word seems to mean power i. e. power-giving oblations. In a Soma and Agni are said to be ready and the mention of *haviṃsi* is naturally expected. Sāyana explains the word by *yajnapāṭi*. *d*:- ā+√*yaj* 'to worship i. e. to secure (something) by means of worship'. (9) *Aṅgirasām*: The word refers to the earliest ancestors (cf. note on III. 4-7). (10). On *raśanā* see Introduction para 7.

X. 110.

Triṣṭubh. This hymn is identical with VS. XXIX. 25-26 and 28-36. (4) *Pradiśā*: 'By ordinance or vedic rule'. cf. I. 101-7 [*rudrāṇām pradiśā*]; I. 164-36 [*Viṣṇoḥ pradiśā*]; also Uvata and Mahidhar on VS. XXIX. 25] *pradiśā śabdāna śrutivākya mahidhiyale*, (5) *Suṣṭvāyāṇā*: see note on II. 3-5b. (6) *Susvayanti*: To be derived from √*susvay* 'to flow or to run' a denominative from *susvi* adj.

the altar. (7) (Come) the first two divine and eloquent *Hotrs*, measuring out the sacrifice for man to worship, as singers inspiring (us) at the assemblies, pointing out the eastern light according to Ordinance. (8) May *Bhīratī* come quickly to our sacrifice and *Ilā* as well, inspiring (us) as she did Manu (or man). May the three Goddesses including *Sarasvatī*, doing good work, sit on this comfortable sacrificial grass. (9) O *Hotr*! Being a wise and a better sacrificer and being implored (by us), worship here to-day God *Tvaṣṭr* who fashioned these two all-creating Heaven and Earth and all beings with their forms. (10) Send up by yourself our offerings to the abode of Gods, anointing them at proper time. May *Vanaspati* and the Immolator God Agni season the offering with honey and ghee. (11) Agni, as soon as he was born, measured out the sacrifice. He became the leader of the Gods. May the Gods eat the oblation offered with *svāhā* according to the guidance and word of this true priest.

'presser (of soma)' from $\sqrt{\text{su}}$ V.P. 'to press' (cf. VII. 36-6b). (7) *Prūcnam jyotiḥ dīśantā*: 'Showing the eastern light i. e. guiding us from darkness to the light of the sun'. Is this a reference to the eastward march of the Āryans in India? (11) *Pradiśi*: 'Under the guidance of' cf. II. 12-7 [*āsvāsaḥ pradiśi yasya gāvah*.]

THE ORIGIN OF THE RĠVEDA.

(An Examination of Dr. Pran Nath's Theory.)

In his articles entitled "The Aryans before B. C. 1000," published in the *Illustrated Weekly of India*, (7th July, 21st July, 4th August and 18th August, 1935), Dr. Pran Nath has presented a novel theory of Aryan Immigration into India, supported by *his interpretation* of some Rġvedic verses. We may agree, perhaps, with the final conclusions of the learned Doctor, but we must remark that his exposition of the new theory, and still more his interpretation of the Rġvedic verses, is anything but convincing. Even a strong case, as all sensible people know, suffers at the hands of an advocate who brings in extravagant evidence to support it. Dr. Pran Nath seems to regard the Rġvedic text as a newly discovered inscription, which lies entirely at the mercy of the interpreter—where he is not only a decipherer of the script, but also a linguist, a philologist, a grammarian, and what not : it is needless to say that a theorist who offers something strikingly new to the public has, of necessity, to be very careful in arguing his case ; still more so in the presentation of old authorities, when new ideas are looked for in them. As a matter of fact, the Rġvedic text, along with the other Vedic texts, is among the most carefully preserved literary monuments of the ancient Hindus, and is strongly backed by a tradition of interpretations, which no scholar, eastern or western, can afford to ignore. Nor can the Rġvedic language, old as it is, be twisted by an interpreter so as to yield a meaning suitable to his own hypothesis. Even Maxmüller thought it necessary to exhort his compatriots to give proper weight and respect to the Indian tradition in interpreting the hymns of the Vedas. It is true that the Rġvedic language is the oldest form of Sanskrit, but still its transition to the language of the *Brāhmaṇas* and *Upaniṣads*, and thence to later or classical Sanskrit, is thoroughly consistent and intelligible. Dr. Pran Nath, therefore, cannot ignore such valuable guides as the exegesis of Yāska or the luminous gloss of Sāyaṇa, the highest Indian authorities ; nor can he disregard the labour of a number of eminent European scholars who have written many scores of valuable books on that earliest written record of the Indo-Aryans. It is quite strange that he has never cited the views of any of those scholars, if indeed they have any, regarding the passages or hymns which he considers as lending support to his theory. On the contrary, he appears to move all alone on that slippery ground

refusing aid from any quarter. He makes commonplace words as pretty uncommon, and by a wonderful change of the key, indeclinables and particles as substantives ; in fact, he seems to regard the well-ascertained meanings of words as unfixed or unknown. No interpreter indeed can afford to overlook the fundamental law of interpretation, namely, that wherever a new meaning is assigned to a word against all tradition it must be well answered by that word in all the contexts where it occurs. If not, it can scarcely be looked upon as the right meaning of the word at all. Accidental coincidence or occasional suitability can never usurp the place of the inherent connotation of words. We are all the more surprised at the strange interpretation of some of the words by Dr. Pran Nath when we consider that all this stuff hails from the ancient seat of Kashi, which for a hundred generations and more has been the sacred repository of traditional Sanskrit learning.

Before we proceed to examine in detail the interpretation of each individual word handled by the Doctor we give below a translation of the whole passage or hymn, consisting of seven ṛks. by Griffith who chiefly follows Sāyaṇa.

1. "With sacrifice I purge both earth and heaven ; I burn up great she—fiends who serve not Indra.
Where throttled by thy hand, the foes were slaughtered and in the pit of death lay pierced and mangled.
2. O thou who castest forth the stone (thunder-bolt,) crushing the sorceresses' heads.
Break them with thy wide-spreading foot, with thy wide-spreading mighty foot.
3. Do thou, O Maghavan (Indra) beat off these sorceresses' daring strength.
Cast them within the narrow pit, within the deep and narrow pit.
4. Of whom thou hast ere now destroyed thrice-fifty with thy fierce attacks.
That did they count a glorious deed, though small to thee, a glorious deed.
5. O Indra, crush and bray to bits the fearful goblin yellow-fanged.
Strike every Rakṣas to the ground.
6. Tear down the mighty ones, O Indra, hear thou us. For heaven hath glowed like earth in fear, O Thunder armed as dreading fierce heat, thunder-armed.
Most mighty mid the mighty ones speedest with strong-bolts of death.

Not slaying men, unconquered here ; with the brave, with the thrice-seven brave.

7. The pourer of libations gains the home of wealth, pouring his gift conciliates hostilities, yea, the hostilities of gods. Pouring, he strives, unchecked and strong, to win his riches thousand-fold.

Indra gives lasting wealth to him who pours forth gifts, yea, wealth he gives that long shall last."

Now it is true that this hymn along with some others by the same author is a little obscure in several places ; and this Griffith himself has admitted. It may also be easily conceded that his translation is not absolutely correct throughout. But the obscurity is very often due to syntactical looseness rather than to haziness hanging upon the individual words. Dr. Pran Nath's interpretations of some of the words are so strange and fantastic that no Sanskritist can harbour them for a moment. He even compounds two words or parts of words in order to twist out of them some novel meaning. For instance "cid" and 'adriyas' are two different words in the text ; they are so marked in the '*pada patha*', and are of very frequent occurrence in the Rġveda. As regards their meaning, no reasonable doubt can arise. We notice an instance of compounding of parts in 'vaṭūriṇā padā', where he takes 'inā' from the preceding and couples it with the following ! And yet all this while he has said not one word in defence of his strange and out-of-the-way procedure. The mere presence of obscurities cannot certainly warrant such a merciless mutilation of the text of the Rġveda, any more than of the difficult books of the old Testament or of the Homeric poems. Besides, whatever doubt or indecision may be entertained by scholars as regards the exact shade of meaning of a difficult word, its grammatical character or syntactical position is in very many cases, perfectly clear. Lastly, will Dr. Pran Nath seriously maintain that 'rodasī' means 'high and low land' throughout Vedic and classical Sanskrit ? For the word is neither peculiar to the Rġveda nor obsolete.

The rare words in the above hymn may be explained as follows :—

1. Abhivlagya :—This is clearly a gerund, though Dr. Pran Nath makes it a substantive to suit his theory. The first part (abhi) is a preposition, while the root 'vlag' means to move or turn. बलगतिर्गतिकर्मा छान्दसो घातुः (Sāyana)
2. Vaila-sthāna :—This is taken to mean an 'abyss' by Griffith. Sāyana's interpretation of it as श्मशान is not very different.
3. Cidadrivas :—These are two different words according to all Sanskritists ; it is sheer monstrosity to compound them as Dr. Pran Nath does, and no further comments are needed.

'Adriyas' is a vocative and the form is pretty frequent in the R̥gveda. It is interpreted by all Sanskritists as 'O Bearer of the thunderbolt'.

4. Vaṭūriṇā:—Adj. of 'padā' Vaṭūri' means 'far-reaching'. It is derived from the root 'vaṭ' to spread. The noun 'vaṭa' which means the 'Banian tree' is derived from the same root:
5. Armaka:—loathsome.

Thus it will be easily perceived that the linguistic evidence on which Dr. Pran Nath lays considerable stress, is utterly unreliable, not to say shockingly unscientific. In attempting to identify 'abhivlagya' with the people of 'Bhibla', 'cid' with 'Shir', 'armaka' with 'Armaean' and 'śārdho' with 'his Majesty of Chaldea', it was at least necessary on his part to prove, firstly, that the Sanskrit words in question are proper nouns; and, secondly, that they suit the context better in that character. For, no interpreter as yet felt even a remote necessity to regard them as such. So far from doing that, Dr. Pran Nath proceeds straightway to fix the location of the supposed places or towns or peoples in a country, which, for aught we know, is never even mentioned by name anywhere in Sanskrit literature.

Mere phonetic semblance, however striking, is rightly regarded by scholars as an evidence unworthy of credence. "Sound philology" says Max Müller "has nothing to do with sound." And in the present case that phonetic semblance is so fantastic, that few will accept it as any evidence at all. We would humbly suggest to Dr. Pran Nath that the R̥gvedic language is as much Sanskrit as the Homeric dialect is Greek; and that the procedure he adopts throughout is so queer that while it may gain easy evidence for any theory, the most irrational, it will surely vitiate any hypothesis, however plausible.

K. M. SHEMBAVNEKAR.

SPECULATION ON VEDIC SPECULATION.*

To an orthodox Hindu of the XX century the Vedas are, at least in principle if not in fact, divinely sacred and mystically authoritative. Throughout the course of its spread and stabilisation the Hindu Society has looked to a Vedic authorisation of each and every phase of its life. From superstition to speculation the Vedas are the *ultima ratio* of a Hindu. Such a position is interesting from two points of view. It suggests, in the first place, a known or unknown (according as the origin of the Vedas is viewed) beginning of the Hindu Society or a conception of it in the Vedic age ; and, secondly, it presumes, on the part of the authors of those Vedic hymns, a constructive intellect and a comprehensive outlook.

What is the nature of this Vedic literature ? Modern scholars hail the Vedic hymns, handed down in a collection (Samhitā), as the finest specimens of primitive poetry and as the first phases of Hindu philosophy. In themselves the hymns are mostly descriptions of and dedicated to facts and forces beyond the ken and control of the primitive man. These facts and forces may be personified for a purpose or may be mere abstract conceptions. That depends on the possibilities of the thought-operations of the primitive mind. To believe without knowing these possibilities would be unscientific ; to judge before we know them would be unsatisfactory. "Developed thought" it is said,¹ "knows certain rigorous methods of induction from experience, as well as certain definite principles of the analysis and synthesis of ideas whereby it forms new conceptions or checks those it has formed. Primitive thought knows nothing of such safeguards. In the lowest strata of thought-operations we form ideas by casual association, drifting where the current of mental tendency leads us, for the most part, under the spell of the emotional or practical interest." What are the thought-operations of the mind behind these hymns ? What kind of experience is it that forms the basis thereof ? Is there an intuitive sense of enjoyment so that we can speak of poetry here, or an intentional understanding so that we can speak of philosophy ? Post-vedic Hindu scholars, from the earliest days, have studied these vedic hymns as a literary piece, as a technical

* These few paragraphs are an attempt to analyse and interpret some of those Vedic hymns, especially in-Mandala X, which are known as philosophical hymns. Here and there I have retained Griffith's translation. (Author)

1 *Morals in Evolution* by L. T. Hobhouse. P. 387.

book, as a law-book, in fact, as everything conceivable. Modern scholars, too, have seen much of that comprehensiveness. "The paramount importance of the Rigveda," says Bloomfield, "is after all not as literature, but as philosophy. Its mythology represents a clearer, even if not always chronologically earlier stage of thought and religious development than is to be found in any parallel literature."²

For us, however, 'the paramount importance' is the vedic seer himself. What would he, let us imagine, say or think if he were to know that we called him a poet and a philosopher? He would, for all we know, stare in bewilderment. He would never understand what we meant. To him there is no such thing or conception as poetry or philosophy. What interests him most is his life—life as he is living without knowing how or why. Nor has he any desire to understand it. The Vedic seer is too honest to be a poet, too frank to be a philosopher. 'Let me have a comfortable home, a beautiful wife, healthy sons, and sufficient cattle' is all that he keeps on saying. Probably the rough primitive life offered him both an inspiration and a pleasure to get what he wanted. That was the interest of his life. He found it a strange world where things were for him without his asking. But increased experience might have shown him that the world be stranger still if everyone were to have what he wanted. This intriguing situation set him thinking. He must be happy and content. What if others were to intervene? Of course, he must fight and protect himself. He must be always a stronger man than the prospective intruder. He must cultivate strength. He must work more with his tribe so that the tribe would stand with him. After all he cannot afford to be too self-centred. "A man should think on wealth and strive to win it by adoration on the path of order; counsel himself with his own mental insight and grasp still nobler vigour with his spirit" [x. 31-ii]. Such was the line of argument along which the Vedic seer, in gradual but growing conviction, came to the conception of some such thing as Law. Law to him was more a self-imposed check than a social convention.

Such self-imposed individual code serves no purpose, as is too obvious. To be good, virtuous, selfless, compromising etc. is no necessity in Nature or the animal World. If man is to grow in an unnatural way he has to be good etc. only by choice. To be good in oneself is neither a vice nor a virtue. To be good to another is a positive virtue. Thus where man does certain things and assigns for them definite reasons, we can talk of Ethics. It seems to us that the ethical conception in the Vedic hymns is the earliest phase of the advancement of the primitive mind and its thought-processes. And it should be true chronologically too.

So arose the conception of a social code of behaviour. But it is one thing to have a social code and quite another to accommodate social life to it. The Vedic hymns give us no hint of the existence of any central authority to guide, compel and supervise such an accommodating social life. Kingship was yet to come, society was still to form. No individual man could arrogate to himself such powers. If that were possible every man could attempt to do it and what every man could do would cease to be a power. Thus, to start with, these necessary powers had to belong to an agency other than man. The vedic seer hoped and then believed that it was so. It was simple enough to imagine a non-human agency. Before he could look around to Nature or up above to the skies the Vedic seer found such an agency within the walls of his very house. The Vedic family was patriarchal. The father of the house was the ruler of the house. Naturally *a father* came to be inherently associated with such authority. Living or dead *a father* will rule. In his life-time he will rule *his* children. After, he will rule *children*. After? Is there any such thing as existence after death? "I have heard," says the Vedic seer, "I have heard mention of two pathways, way of the Fathers and Gods and that of the mortal beings. This world, born of fathers and mothers, proceeds along those two paths before it ultimately meets in one place." [X. 88-xv.]

Side by side with the conception of Law arose the conception of Power. As a matter of fact Law and Power go hand-in-hand. Power, like Law, is above the mortal beings. It is for this reason that even the First Mortal and the Ancient Father, Yama, stands in fear of Law. When his sister Yamī attempts to seduce him to an incestuous union he bursts out "Who knows that earliest day whereof thou speakest? Who hath beheld it? Who can here declare it? Great is the law of Varuṇa and Mitra. What, Wanton! Wilt thou say to men to tempt them?" [X-10-vi]. Not only the Fathers but even the Gods fear and follow Law. "God creates the gods according to Law" [X-12-ii]. In thus following the line of his own arguments the Vedic seer had to create God and the gods. They are nothing but the replica of Father and the mortal beings. We should guard ourselves here against confusing this God and the gods with deities like Agni, Varuṇa etc., which are also later on called gods. Neither in their origin nor in their growth are the mythological deities connected with the conception of God and the gods. God as the Vedic seer saw him was none but the Father at home ruling with a rod. "Let not the Father—the Father of the whole world—punish us" is his child-like hope. [X-121-ix].¹

1 *Religion of the Veda*, P. 29.

In his attempt to understand and secure his relations with other men the vedic seer stumbled on Law and God. But the cause of man's fear is not merely another man. Worse than his human neighbour whom he can understand and meet on equal grounds is the danger from factors beyond human control. A Vedic house-holder may protect his children from the wild animals, may rescue his cattle from an adventurer and so on. But who could protect those very children from deadly diseases? Who could save the cattle safe through a storm or a dark night? In its very helplessness the primitive mind could fondle a hope; in its child-like simplicity it could imagine a solution. Safety and security there must be. I meet my punishment at home if I am mischievous. I meet punishment outside. So I must have been mischievous outside. If I hit anybody I will be hit back. I am hit with the loss of my cattle. So I must have had hit someone who, as a counter-measure, has lifted my cattle. That must have been the way in which the Vedic mind argued to itself. To imagine an altogether unseen mischief-monger was neither possible nor fruitful. Whoever lifted the cattle must be known to us, must be amenable to us. If the calamity takes place in a storm then it is the storm itself, if in darkness then it must be the setting Sun himself who must have set earlier simply to punish me. Thus we come across hymns that are purposeful prayers to such extraneous causes of destruction. In the earliest stages fear must have been the main motive. The evening Sun (Pūṣan) is requested to lead the cattle safely home, the Storm to abate, the Rain to shower and so on. In doing this the Vedic seer must presume that the sun, the storm etc., have human feelings. On this presumption he naively believes that these objects have human failings also. Ultimately it turns out that the Vedic seer deals with these objects in the same way in which he deals with his fellow-men. Just as the policy of give-and-take was found convenient in the case of his immediate neighbours so was it found convenient in the case of these external forces. If the Sun, the Storm, the Rain etc., are gods they are so not because there is any divinity about them but simply for the reason that *they are not ordinary* human beings. In the early stages none of these forces is raised to an all-powerful or divine status. None of them is great on its own merits. The Sun is great not because he illuminates the whole world but simply because he leads the singer's cattle safely home. Likewise Fire is great not because it has got superhuman or mystic powers but for the obvious reason that it helps the singer to cook his food and warm his house. As far as the early stages are concerned it would not be possible to agree with Max-Müller when he says, "The gods of the Vedic, and indirectly of all the Aryan people, were the agents postulated behind the great phenomena

of nature”¹ It seems to us that of the Vedic seers, very few, indeed, were concerned with “the great phenomena of nature” and fewer still did ever think “to postulate agents” behind them. Agni, Sūrya, Varuṇa etc., in the Vedic hymns are neither the agents behind nor the personified forces within the phenomena of nature. They are not gods. Like human beings they are the creation of the Primeval Unborn. [X-82-vi].

The only peculiarity about them is that they are nonhuman, non-mortal (*amṛta*). Nevertheless they are members of the same cosmos of human beings. As such they are bound by the same social code. They are richer and greater just as one man is richer and greater than another. Thus the Seer to Agni :—

“Oh Thou non-mortal, who wanderest the seven regions, give unto the liberal ; let him who approaches Thee *with fuel* be favoured with healthy sons and abounding wealth.

“Thou art the knower of Sacrifice, (for) Thou art the first officiating priest.” [X-122-iii-iv].

The words in italics are sufficient to show to us the nature of Agni. It is the ordinary fire itself that feeds on fuel. So with Sūrya, Varuṇa and many other “deities of the Vedic mythology.”

The Vedic man thus found himself in a world not confined merely to the earth he walked on but one that encompassed ‘the path of the Sun’ ; and his companions were not only his fellow-men and the domesticated animals but also those natural phenomena on whose functioning his life depended. It is unnecessary to detail here the stages along which he came to realise his helplessness in such a world. Realise he did ultimately that these phenomena were entirely different from him in nature, functioning and potentialities. As a human being he himself was born, grew up and did finally age to decay. On the contrary the natural phenomena, though born anew as he saw them, never did age to decay. Never could they be destroyed in such a way as to be entirely different and unrecognisable when born anew. The fire was the same fire, with the same hue and glow, produced at any and every time. The sun was just the same himself each morning. Similarly the Vedic poet sings of the Dawn “Thou art ever the same, un-ageing.” It should not be supposed at this stage that there was any conception of Immortality. Whenever the word *a-mṛtya* is used it only means ‘non-human’ whatever that meant to the Vedic mind. Agni, for example, could not be said to be immortal. He is born like other human beings. “Born many a time he views the hearts within us” [x-5-i]. But when was he born first? Nobody knows. So he must have been born before everyone else. So

"Agni is the First-born" [x-5-vii]. In such like conceptions the Vedic seers were stepping from the world of facts into that of fancies. So they attempted in hundred and one ways to understand these natural phenomena as human beings. The varied descriptions of the parentage etc. of Agni, Sūrya and so many other deities do not directly concern the scope of the present essay. But one thing to be noted in connexion with the growth of this mythology is the fact that the construction of a 'non-human' world led ultimately to the beginnings in philosophical speculations. If Agni, Sūrya etc. are our companions and if they have a particular parentage is it not possible that we too should be having the same parentage? If *Dyauh*—the Celestial Region—is the Father of Agni, Sūrya etc. it must be our Father also. "He who, as the Hotri-priest, offered all the beings is our Father" [x-81-i].

The conception of a Universal Father is not the only attempt to be met with in the Vedic hymns, to explain and understand the origin of the world. The Vedic seer was bold enough to believe in his every-day experiences and wise enough to apply those observations to his speculations. The explanation of the birth of the deities made the question of the birth of the Universe still more interesting. How was such a magnificent world, wherein these deities live and move like human beings, itself produced? The seer calmly suggests that it was produced like things are produced in ordinary life. Thus the first explanation is that the world is the result of procreation as in the case of animal beings. Sky is the father, Earth the mother and 'on the lap of the mother,' 'in the womb of the mother' [x-5-vii] is the world produced. Similarly the Bull and the Cow are oftentimes mentioned in connexion with the Origin. [x-5-vii; x-31-viii]. In the famous dialogue-hymn of Yama and Yami the poet takes up a situation where if the world were to be a result of procreation, the first union would be an incest. "Let the Vedhas give a son unto a father if He is to see to the development (of lives) on this earth" [x-10-i]. With these words Yami opens her argument of seduction. The entire hymn may be said to be a criticism of the view that explained the origin of the world as a procreative process.

The Vedic seers were not so keen to arrive at the Ultimate Truth as to attempt to understand just what they saw. In this respect the description of the Upaniṣads by Sir Radhakrishnan applies equally well to the Vedic hymns. "The aim of the Upaniṣads," says the eminent thinker, "is not so much to reach philosophical truth as to bring peace and freedom to the anxious human spirit. Tentative solutions of metaphysical questions are put forth They express the restlessness and striving of the human mind to grasp the true

nature of reality.”¹ The difference between the Vedas and the Upanisads is just the difference between a child and a man. For this reason do we find that the cognates of the Vedic seers are drawn on Mythology while those of the Upanisad sages are drawn on Mysticism. Conclusions in both cases were based on analogical experiences of life. The deities of the Vedic householder were human in functions and powers ; only the sphere of those functions and powers was far, far wider. The world to the Vedic seer was not at all different from the house he lived in ; nay, the world was only the biggest house—built like any other house and with the same materials. The Universal Father built this Universal Home. Thus does the Vedic seer explain the origin of the world. “What was the tree, what wood, in sooth, produced it from which they fashioned forth the earth and heaven? These twain stand fast and wax not old for ever ; these have sung praise to many a day and morning,” [x-31-vii]. To build a house of mud-walls and a thatched roof, wood and other materials are required. The Father too could not do without them. Again in another place the same idea is repeated [x-81-iv]. Thus the Father is oftentimes referred to as the Architect, the Master-BUILDER and so on. “He is our Father, he our creator ; he builds all abodes and knows all the beings.” [x-82-iii]. Naturally enough this Vishwakarmā is described as “He who hath eyes all over, faces all round himself, arms everywhere—he protects all and fans the earth and the heaven with his arms as with wings as he alone creates them.” [x-81-iii]. Now and then the First Creator is referred to as a blacksmith. “Brahmaṇaspati produced all these with blast and smelting like a Smith.” [x-72-ii]. He is probably a mason in x-82-i. “Father of the diligent, confident in plans, he (Vishwakarmā) first prepared water (i.e. mud) and then he fixed firm and wide the heaven and the earth from out of it.” Lastly, he is referred to as a carpenter or a tanner (Tvaṣṭā).

The foregoing suggests, if anything, that these seers are more poetic than philosophical in their speculations. On the analogy of human procreation and material construction they postulated a Father and an Architect as the creator. But as their sphere of observation widened the scope of their speculation shifted. The world of the Vedic seers, as has been said, was not merely the animal world. The vegetable life of wild growth as well as of cultivation must have offered another way of explaining the origin and growth of the world. Whatever would contribute to the growth of vegetable life would equally contribute to the growth of the world. Water comes first under this heading. So we are not surprised when the seers sing

1 *Philosophy of the Upanisads*, p. 14.

of Water as the first abode of the protoplasmic element. "That which is earlier than this earth and heaven, before the Asuras and gods had being,—what was the *germ primeval which the waters received* where all the gods were seen together." [x·82·v].

There was another phenomenon which struck the primitive mind as a probable explanation of Life. Light and Darkness, following one another in eternal and regular continuity, the one brilliant and helpful and the other terror-striking, must have filled the poetic hearts of the vedic seers with awe and admiration. The Sun is up and the whole world is moving; Darkness envelops and the whole world is at a stand-still. By a simple process of induction Light was looked upon as the life-giver and Darkness as death. Perhaps the vedic mind refused to think of death and looked upon Darkness not as an end but as a beginning. What is to be understood is not the end but the origin of life. Hence we always meet in the hymns with the idea that Darkness enveloped the universe at the beginning. Thus sings the Seer "The world was swallowed and concealed in darkness; Agni was born and light became apparent. The deities, the broad earth, and the heavens, and plants, and waters gloried in his friendship." [x-88-ii]. Similarly in the famous *nāsadiya* hymn the singer asserts; "Darkness there was; at first concealed in darkness this All was indiscriminated chaos. All that existed then was void and formless; by the great power of Warmth was born that Unit." [x-129-iii]¹

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(to be continued)

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1. Cf. the Footnote to Griffith's translation.

THE TEXT OF THE TATVĀRTHĀDHIGAMA-SŪTRĀNI

Most of the philosophical schools in India have a Sūtra work of their own which summarises and arranges their philosophical tenets. The only Sūtra work of Jainism of any importance is no doubt the Tatvārthādhigama-Sūtrāṇi¹ of Vācaka Umāsvāti, which is their most authoritative book. Besides being the clearest epitome of the Jain philosophy, it has the further advantage of being recognized as authoritative by both the sects of the Jain community, the Digambaras and the Śvetāmbaras. Both the sects accept the text of the work with slight changes in the Sūtra Pāṭhas. Its popularity and importance can be further seen by the great number of commentaries and sub-commentaries on it written by the greatest scholars of both the sects. Tradition would like us to suppose that the whole of the work in its present shape belongs to Umāsvāti, and embodies the philosophical principles of Jainism as preached by Mahāvīra their last Tīrthaṅkara. But the work presents us many interesting problems about its text and its development which it is worth our while to consider.

The Sūtra work of Umāsvāti has come down to us in two different recensions each belonging to one of the two sects of the Jain community. The Śvetāmbara recension differs greatly from the one accepted by the Digambaras both as regards its wording and interpretation. Another important difference between the traditions of these two communities is the fact that the Digambaras own only the Sūtras as the work of Umāsvāti and the commentators of this sect write their glosses on the Sūtras only, while the Śvetāmbaras add a Bhāṣya to the work which they attribute to Umāsvāti himself and call it a Svopajña Bhāṣya. Thus both the Sūtras and the accompanying Bhāṣya form the text to the Śvetāmbara commentators to comment upon. This difference has caused many other divergences between the two sects. Of them the question of interpretation and the consequent differences of opinion on theological points is of less importance in determining the textual problems of the present work and are of no far-reaching results. They turn on points like the question of regarding living beings embodied in the elements of fire and wind as movable or immovable², the number of the heavens and hells and the

1 It is to be noted that of the Sūtra works of the heterodox systems of philosophy we know only two, the Brhaspati Sūtras of the Cārvākas and the present work belonging to Jainism and have only the later one.

2 T. S. II, 13 and the corresponding Sūtra of the Digambara recension.

number of the *Nayas*¹ which last again is only a difference in the process of division more than in the final result. But the other two differences of the wording and the authorship of the *Bhāṣya* are important to us and must be taken for a detailed consideration.

One of the differences which strikes one prominently in comparing the two recensions of the *Sūtras* is the difference of wording that is found in the two *Sūtra Pāthas*. One thing can be easily seen in it, that is, the difference mainly pertains to the technical terms of the Jain philosophy and theology used in the work. In *Sūtra VII, 4* the word *Apāya* is found used which is also to be met with in the same form in the corresponding *Sūtra* of the *Digambara* version. The meaning of this word used in this context is the usual one of danger. But in *Sūtra I, 15* the same word *Apāya* which is used in its technical sense of one of the four divisions of the *Matijñāna* is found transcribed in the *Digambara* version in the form of *Avāya*. This leaves no doubt as regards the exact scope of these verbal differences. Similarly where the *Śvetāmbaras* read *Manahparyāya* (I, 24, 25,), *Upapāta* (II, 32, 35), *Aupapātika* (II, 47), *Parāpare* (III, 17) and *Visarga* (V, 16) the *Digambara* Version is found to use *Manahpar-yaya*, *Upapāda*, *Aupapādika*, *Parāvare* and *Visarpa*. Now the difference between these two sets of the terms is such as to suggest an obvious explanation. These terms, mostly technical in meaning, were originally current in their *Prakrit* form in Jain philosophy and are found in abundance in the Jain canon. The two sects translated them in Sanskrit in two different ways and produced these two sets of words which was helped by the ambiguous and flexible nature of the *Prakrit* language. This fact, if true, reveals naturally another interesting point about the language in which the Jain canon must have been written. It shows that in that language both *t* and *d* were represented by one and the same sound, a conjunct was the cause of shortening a long vowel before it and *p* and *v* were reduced to one sound.

This fact, that the technical terms in the *Sūtras* have a *Prakritic* origin, has led some to believe that the whole of the *Tat-vārthādhigama-Sūtrāṇi* was originally written in a *Prakrit* dialect and was later rendered into its present Sanskrit form. There is however not sufficient evidence to conclude that the work was in *Prakrit* and the adduced parallel of the *Mokkhamaggagai*, the 27th chapter of the *Uttarādhyayana* is certainly inadequate. There are no doubt a few facts which would give colour to such a theory. The work is called in the *Sambandha-Kārikās*² by the name *Mok-samārga* and there appears to be an apparent similarity of form

1 T. S. I, 34.

2 No. 31.

between them as both begin with a definition of the so-called Mokṣamārga. But more than this similarity the differences between these two works are more important and far-reaching. The work of Umāsvāti is better known by its other title Tatvārthādhigama-Sūtrāṇi which is also mentioned in another¹ of the Sambandha-Kārikas. The word Ākhyā used there leaves no doubt that the author intended it to be the real name of the work, while the words Mokṣamārga in verse 33 are intended to introduce the first Sūtra. About the authorship of these verses we have to conclude that they have a greater chance of being the work of Umāsvāti himself and that would give it a greater support. Similarly a comparison of the work with the Uttarādhyaṇa chapter reveals many points of divergence between the two. While the Tatvārthādhigama includes in its conception of the Mokṣamārga only the three jewels of Jainism, Samyag-Darśana, Samyag-Jñāna and Samyak-Cāritra the Uttarādhyaṇa adds Tapas to it. The treatment of Samyaktva between the two works is also completely different², and while the Tatvārthādhigama³ gives only the seven Tatvas the Uttarādhyaṇa gives the nine Padārthas⁴ as the basis of treatment.⁵

More important is the question about the authorship of the Bhāṣya which, as said already, is the bone of contention between the two sects of the Jain community. In the present state of our knowledge it is very difficult to decide the question one way or the other. Usually three different arguments are advanced⁶ to prove the common authorship of the Sūtras and the Bhāṣya. It is pointed out that the writer of the Bhāṣya, while introducing the Sūtras uses the first person forms like Pravakṣyāmi, Vakṣyāmah⁷ which would go to prove that the author of both the Sūtras and the Bhāṣya is one and the same person. To this is added the fact that unlike other Sūtra works the present one has not suffered much in interpretation which can be explained by supposing that the Sūtrakāra himself explained his work in his Bhāṣya, putting all innovations in interpretation to silence. And lastly it is pointed out that at the end of the Bhāṣya the writer refers to himself by the name Umāsvāti.

But on a closer scrutiny it will be seen that the arguments are not very convincing and leave many loop-holes in them. Against the few instances of the use of the first person occurring in Sūtras v, 22,

1 No. 22.

2 Kundakunda and others add Tapas in such a context.

3 T. S. I, 1. Uttā. XXVII, 2.

4 Uttā. XXVII, 16-27. T. S. I, 2 foll.

5 Uttā. XXVII, 14; T. S. I, 3.

6 Cp. Pt. Sukhalalji in Anekānta.

7 Sambandha-Kārikā 31; V. 37.

37, and 42 there are a host of others in which the third person is used throughout, as *Atrocyate*, *Atrāha*, and *Uktaṃ bhavatā* and similar expressions¹. The only conclusive argument in such cases would be a reference in the *Sūtra* to a passage or topic dealt with in the *Bhāṣya* only, as is the case with the *Kārikās* of *Kāvyaaprakāśa*. But such a reference we find nowhere in the present case. Further we have the instance of *Jinabhadra* who in his *Viśeṣāvaśyakabhāṣya* on the *Āvaśyaka-Niryukti* introduces a *Gāthā* of *Bhadrabāhu* with the use of a first person form.² On the other hand we have indications to show that the *Sūtrakāra* was different from the *Bhāṣyakāra*. Very often in the beginning of chapters three and four, and in some other places the *Bhāṣyakāra* uses the words *Uktaṃ bhavatā* in referring not only to the *Sūtras* that went before it but also to those that are yet to come.³ The full force of this use of past tense the commentators appear to have missed as they were led away by their own preconception of regarding the two works as the writings of one and the same author. But in a similar case *Abhinavagupta* in his *Locana* on the *Dhvanyāloka* where he appears to regard the author of the *Vṛtti* as different from the author of the *Kārikās* remarks on the words *Darśitam eva agre, darśitameveti kārīkākāreṇa iti bhūtapratyayah*.⁴ This leaves no doubt as to the significance of the past tense. At least it is clear that all the *Sūtras* were ready, before the writer of the *Bhāṣya* began to write down his own work. Nor is the argument from the lack of divergent interpretations sufficient to prove the mono-authorship of the two works. It will at the most give credit to the author for writing clear and unambiguous *Sūtras* leaving no scope for the commentators to distort and misinterpret them. The verses at the end of the *Bhāṣya* would at first lead one to suppose that the *Bhāṣya* is the work of *Umāsvāti* himself. But a careful reading of them gives no hint to such a view. They can very well be supposed to be the work of the *Bhāṣyakāra* who is supplying us information about the author of the *Sūtras*, and it is difficult to see how they confirm the view that the *Bhāṣyakāra* was *Umāsvāti* himself. On the other hand it is inconceivable that he would have praised himself in those terms found in them. The case of the *Sambandha-Kārikās* at⁵ the beginning is a little different. I see no reason to say that they do not belong to the writer of the *Sūtras*. Beside the use of the words *Vakṣyāmi* and *Pravakṣyāmi* the style of these verses is certainly superior to that of the *Bhāṣya* and it is not an impossibility that the

1 cf. T. S. I, 25, 26, 27, 31 and so on ; II, 25 etc.

2 I am indebted to Prof. Upadhye for this information.

3 Cf. *Bhāṣya* on IV, 1.

4 *Kāvya-mālā* No. 25 p. 138.

5 *Pūjyapāda Akalanka* and others do not give these verses.

the writer of the Sūtras should have prefixed a few Kārikās to his Sūtras by way of introduction. In fact they discharge that function admirably. This will also explain the quotation of these verses by later writers as the words of Umāsvāti even though no great weight can be placed on it, because very early there arose the tradition of the mono-authorship of the Sūtras and the Bhāṣya. The oldest available commentary on them, the Sarvārthasiddhi of Pūjyapāda¹ only comments on the Sūtras and neglects the Bhāṣya altogether, which procedure is inexplicable on any other supposition than the fact that Pūjyapāda regarded the Bhāṣya, if at all he knew it, to be not the work of the writer of the Sūtras.

About the development of the present Sūtras it is not possible to state anything with confidence and with an air of certainty. It is only a few suggestions and traces of such a development that we can hope to glean in the existing work itself. If we look at chapters three and four of the present work we find many traces to conclude that they may be later additions to the original work. One fact that strikes us at the beginning is the presence of the two names that are given to these chapters, the Lokaprajñapti and Devagatipradarśana, while the names of the other chapters are not found or did not exist. The names of these two chapters are such that they indicate the nature of these sections as independent works, and other works bearing similar titles are found in Jain literature². Moreover, the two recensions of the Sūtras are found to differ unusually at a greater length in these two chapters only. In the third, the Śvetāmbara recension has only 18 Sūtras while the Digambara one counts as many as 39, leaving a difference of 21 Sūtras. The difference of the fourth chapter is 11 while the next greatest difference is only 5 found in the 7th chapter. This is a clear indication to show that these two chapters are of a later origin. One more argument that is to be noted in this connection is the defective arrangement of the fourth chapter. We usually find Umāsvāti very consistent and accurate in arranging his material. But such is not the case with this chapter. It begins with the statement that gods are divided into four groups,³ and what we next expect is the names of these four Nikāyas. But the next Sūtra states that the third group is characterised by the yellow Leśyā. Another fact pointing to a similar conclusion is the style of the Bhāṣya on these two chapters which differs from the remaining portions.

Another group of Sūtras that intrude on the general arrangement of the work is found in chapter fifth and includes Sūtras 29-31. In

1 Ed. by Nitave at Kolhapur.

2 Cp. Jambudvīpaprajñapti, Sūryaprajñapti Candraprajñapti and other works.

3 T. S. IV, 1.

fact Sūtra 32 should naturally follow without a break on Sūtra 28 as being of the same train of thought. An external indication to show the interpolatory character of these Sūtras is the difference which the comments of both Siddhasena and Haribhadra show in accepting the extent and wording of the text. Moreover the general discussion of the nature of existence should either come at the end of the chapter as is the case with the general discussion about Drāvyā, or if possible at the beginning. Again the enumeration of the four Nayas based on Sūtra 31 should have been dealt with in the first chapter where the topic was once opened. The Nature of these Nayas and their novel names and the great pains that Siddhasena takes to make them square with the usual seven Nayas would point to a similar conclusion. If another suggestion can be made of the original scheme of the Sūtras, we expect that chapter nine should have been divided into two at Sūtra 18, each part being devoted to each of the two principles, Saṃvara and Nirjarā.

We have again a suggestion or two in the book itself which would throw light on the difference of number of the two recensions of the Sūtras, the Śvetāmbara one containing 344 and the Digambara recension having 367 Sūtras. At the end of chapter 8 we have in the Bhāṣya on Sūtra VIII, 26 the concluding words "ato anyat pāpam" which the Bhāṣyakāra deduces by implication from the Sūtra itself. But these very words form a Sūtra in the Digambara version as Sūtra VIII, 26. Similarly a portion of the Bhāṣya from "syādetat lokāntāt" upto "mukto niḥkriya iti" on Sūtra X, 6 in the Śvetāmbara recension is certainly not a Bhāṣya on Sūtra 6 as is supposed by the commentators. The passage runs as follows. "syādetat lokāntādapyūrdhvaṃ muktaṣya gatiḥ kimarthaṃ na bhavati/ Atrocyate/ *Dharmāstikāyābhāvāt*/ Dharmāstikāyo hi jivapudgalānāṃ gatyupagraheṇa upakurute/ Sa tatra nāsti/ Tasmāt gatyupagraha-kāraṇā bhāvāt parato gatiḥ na bhavati apsu alābuvat/ Nādho na tiryak ityuktaṃ/ Tatveva anuśreṇigatiḥ lokānte avatīṭhate muktaḥ niḥkriyaḥ iti/ " From this it is clear that the words atrocyate introduce a new Sūtra which is given as *Dharmāstikāyābhāvāt* which is further explained by the Bhāṣya that follows it. And in fact this Sūtra is found in the Digambara recension as Sūtra X, 8. It is also not very difficult to explain the confusion in which the commentators have fallen while explaining the previous Sūtra. The Bhāṣyakāra again uses the simile apsu alābuvat but in a slightly different sense, which can be easily explained with the help of the context. It means that just as the alābu cannot go further on its course when it reaches the

1 Cf. 23 Bhedasamghātābhyām Cāksusah, and 32, Snigdharuksatvāt bandhah.

2 Ed. by Kapadia Vol. I, p. 261, 320, Vol. II. p. 101 etc.

surface of the water so is the case with Jīva which also cannot proceed further on its course. But misled by the simile as being adduced from Sūtra 6 where it is already used they take the whole passage as the words of the Bhāṣyakāra on the earlier Sūtra.

This point raises the important question about the origin of the two recensions. Even though we have already explained the major portion of it as due to later additions or misrepresentation, a few still remain which it is difficult to explain with the present available material. But one thing becomes clear and that is the Śvetāmbara recension must have suffered greater changes in its course than the Digambara one. This is further corroborated by the fact that the Sūtras and the Bhāṣya being regarded as the work of one and the same person it was not possible for them to keep these two works fully distinct. It can also be gathered from the remarks of Siddhasena in his Bhāṣyānuṣāriṇī where he very often complains of previous writers who appear to have confused the text of the Sūtra and the Bhāṣya with each other.

A. M. GHATAGE

THE SCHEME OF BRAHMASŪTRAS I. 1-3 : A RAPPROACHMENT.

In this paper an humble attempt is made to find out the original scheme of the author of the Brahmasūtras in the arrangement of the *viṣayavākyas* or the Srutis selected for discussion in the first three Pādas of the first Adhyāya of his work. No adequate justice can be said to have been done to this subject without offering a consistent interpretation of *all* the Sūtras of Bra. Sū. I. 1-3. But looking to the narrow compass of this article it is not possible to deal with it here and I, therefore, leave it for some future occasion. Here only the results of my study of the portion of the text in question are, briefly, presented with a request to scholars to make their own suggestions on the problem.

The following is a table of the *viṣayavākyas* in Bra. Sū. I. 1-3 according to the commentary of Śaṅkara with whom Ramānuja and Vallabha agree and from whom Thibaut and Deussen do not differ :—

No. of Adhikaraṇa.	Śrutis discussed in Bra. Sū. I.		
	Pāda 1.	Pāda 2.	Pāda 3.
1		Chā. Upa. III. 14-1-2	Mu. Upa. II. 2.
2	Tai. Upa. III. 6	Ka. Upa. II. 24.	Chā. Upa. VII. 23-1
3		III. 1-2	Br. Upa. III. 8-12
4		Chā. Upa. IV. 15-1	Pra. Upa. V. 5-7
5	(Chā. Upa. VI. 2-1-3)	Br. Upa. III. 7-1-2	Chā. Upa. VIII. 1-1,5
6	Tai. Upa. (II. 8 or) III. 9.	Mu. Upa. I. 1-5-6	Mu. Upa. II. 2-10
7	Chā. Upa. I. 6-7	Chā. Upa. V. 11-18	Or Ka. Upa. V. 15
8	Chā. Upa. I. 9-1		Ka. Upa. IV. 11-13
9	Chā. Upa. I. 11-4-5		
10	Chā. Upa. III. 13-7		Ka. Upa. VI. 1-2
11	Kau. Upa. III. 2		Chā. Upa. VIII. 12-3
12			Chā. Upa. VIII. 14-1
13			Chā. Upa. IV. 3-7

In the above table the *viṣayavākyas* are mentioned in the consecutive order of the Adhikaraṇas ; but if we group the *viṣayavākyas*

according to the Upaniṣads and the Pādas of the Brahmasūtras we get the following order of their selection or choice by the Sūtrakāra:—

Name of the Upaniṣad.	Pāda 1.	Pāda 2.	Pāda 3.	Total No. of Śrutis from each Upaniṣad.
1 Tai. Upa.	(1) III. 6, (II. 8 or) III. 9.			2
2 Chā. Upa.	(VI. 2-1-3) (1) I. 9-1; (2) I. 11-4-5; (3) III. 13-7.	(4) III. 14-1-2; (5) IV. 15-1; (6) V. 11-18	(7) VII. 23-1; (8) VIII. 1-1, 5; (9) VIII. 12-3; (10) VIII. 14-1.	10
3 Kau. Upa.	III. 2.			1
4 Katha Upa.		(1) II. 24; (2) III. 1-2;	(3) IV. 11-12; (4) VI. 1-2.	4
5 Br. Upa.		(1) III. 7-1-2	(2) III. 8-12; (3) IV. 3-7.	3
6 Mu. Upa.		(1) I. 1-5-6	(2) II. 2-5; (3) II. 2-10.	3
7 Pra. Upa.			(1) V. 5-7.	1

Note—The *ānandamaya* Śruti discussed in the Bra. Sū. I. 1. 12. may be either Tai. Upa. II. 8 or more probably III. 9. The purpose of the reference to Chā. Upa. VI. 2. 1-3 in this context (Bra. Sū. I. 1. 5) is, I think, to defend the statement in Bra. Sū. I. 1. 2 and therefore that Śruti cannot form an independent *viśayavākya*, nor can that Sūtra (I. 1. 5) go to form a new Adhikaraṇa.

A glance at the above order of the selected *viśaya-vākyas* would show that, in the case of each of the Upaniṣads, the Sūtrakāra has strictly observed the original *order of the Upaniṣad* in marshalling the various *viśaya-vākyas* in their proper order in the different Pādas. Thus, in the case of the Taittiriya Upaniṣad the first *viśayavākya* is Tai. Upa. III. 6 and the second is Tai. Upa. III. 9; the order of the Śrutis selected from the Katha Upaniṣad is as follows:—(1) II. 24, (2) III. 1-2, (3) IV. 11-12, (4) VI. 1-2; that in the Muṇḍaka Upaniṣad:—(1) I. 1. 5-6, (2) II. 2-5, and (3) II. 2-10; and that in the Bṛhadāraṇyaka Upaniṣad:—(1) III. 7-1-2, (2) III. 8-12, and (3) IV. 3-7. Similarly the Chāndogya Upaniṣad Śrutis selected by the Sūtrakāra are in the following order:—(1) I. 9-1, (2) I. 11-4-5, (3) III. 13-7, (4) III. 14-1-2, (5) IV. 15-1, (6) V. 11-18, (7) VII. 23-1, (8) VIII. 1-1 and 5, (9) VIII. 12-3, and (10) VIII. 14-1.

Thus, it is seen that the Śrutis selected by the Sūtrakāra from any particular Upaniṣad are exactly in the order in which they originally occur in that particular Upaniṣad. So only on the ground of the

*serial order*¹ of the Chā. Upa. Śrutis we cannot conclude that the original of the Brahmasūtras was a "Chāndogya Upaniṣad Brahmasūtra," because the serial order is also found to have been observed in the case of the Śrutis selected from all the other Upaniṣads discussed by the author. The fact that *ten* Śrutis have been selected from the Chā. Upa., whereas only four (or rather five if we accept Śaṅkara's interpretation of Bra. Sū. I. 3. 22) and three have been taken from the Kaṭha and Muṇḍaka Upaniṣads respectively, which are comparatively much shorter than the Chā. Upa., does not in itself go to prove the preponderance of the Chā. Upa. Śrutis in Bra. Sū. I. 1—3; nor does it seem to me to offer a definite suggestion regarding the original framework of the Brahmasūtras or the arrangement of the Śrutis in Bra. Sū. I. 1—3.

In my opinion, the scheme of the selection and arrangement of the Śrutis in Bra. Sū. I. 1—3 is suggestively clear in Bra. Sū. III. 3. 11 (*ānandādayaḥ pradhānasya*) and III. 3.38—39 (*saivhi satyādayaḥ and kāmādītaratra tatra cāyatanādibhyaḥ*).

Before interpreting these Sūtras as I understand them, I wish to point out that these Sūtras refer to *three* groups of attributes or thoughts (*dhis*—Bra. Sū. III. 3. 33) of the Supreme Being, viz. (1) *ānandādayaḥ*, (2) *satyādayaḥ* and (3) *āyatanādayaḥ*. The ancient commentators and the modern interpreters of the Sūtras have not within my knowledge, been able to point out anywhere the existence of *three* lists corresponding to the requirements of the three *bahuvrīhi* compounds. To me it seems that *ānandādayaḥ*, *satyādayaḥ* and *āyatanādayaḥ* respectively refer to the first three Pādas of the first Adhyāya of the Brahmasūtras.

Bra. Sū. I. 1. 2 refers to the Śruti which mentions *ānanda* viz., *ānandād dhyeva khalyimāni bhūtāni jāyante ānandena jātāni jīvant ānandam prayantyaḥ hisaṃvīṣantīti* (Tai. Upa. III. 6). So, *ānandādayaḥ* would mean (1) *ānanda*, (2) *ānandamaya* (Bra. Sū. I. 1. 12), (3) *antar . . . puruṣa* (Bra. Sū. I. 1. 20), (4) *ākāśa* (Bra. Sū. I. 1. 22), (5) *prāṇa* (Bra. Sū. I. 1. 23), (6) *jyotiḥ* (Bra. Sū. I. 1. 24) and (7) *prāṇa* (Bra. Sū. I. 1. 28).

The list of the second *bahuvrīhi* compound, *satyādayaḥ*, seems to have been made up of the 'thoughts' mentioned in the second Pāda of which the *first viśayavākya* is as follows: *manomayaḥ prāṇāśarīro bhārūpaḥ satya sankalpaḥ ākāśātmā* (Chā. Upa. III. 14. 2). The word *satya* in *satyādayaḥ* seems to stand for *satyasamkalpa* in the first *viśayavākya*. So, *satyādayaḥ* would imply the attributes of the Supreme Being as collected in Pāda 2, viz., (1) *manomaya* etc. (Bra. Sū. I. 2. 1.), (2) *attā* (Bra. Sū. I. 2. 9), (3) *guhām praviṣṭa* (Bra.

1. Vide Dr. Belvelkar's article on 'The Multiple Authorship of the Vedānta Sūtras', Vol. II. No. 2 of The Indian Philosophical Review, October 1918.

Sū. I. 2. 11), (4) *antarāḥ* (Bra. Sū. I. 2. 13), (5) *antaryāmin* (Bra. Sū. I. 2. 18), (6) *adrśyatvādiguṇaka* (Bra. Sū. I. 2. 21), and (7) *vaiśvānara* (Bra. Sū. I. 2. 24).

The list of the *third bahuvrīhi* compound, *āyatatanādayaḥ* seems to be made up of *dyubhṛvādīyātana* in the *first* Sūtra in the third Pāda and of the other attributes collected by the Sūtrakāra in the same Pāda, viz., (2) *bhīmā* (Bra. Sū. I. 3. 8), (3) *ambarāntadhṛti* (Bra. Sū. I. 3. 10), (4) *ikṣatikarma* (Bra. Sū. I. 3. 13), (5) *dahara* (Bra. Sū. I. 3. 14), (6) *aṅguṣṭhamūtra* (Bra. Sū. I. 3. 24), (7) *kampana* (Bra. Sū. I. 3. 39), (8) *jyotiḥ* (Bra. Sū. I. 3. 40), (9) *ākāśa* (Bra. Sū. I. 3. 41), (10) *viññānamaya* (Bra. Sū. I. 3. 42), and (11) *pati* (Bra. Sū. I. 3. 43).

As the very words *ānanda* and *āyatana* occur respectively in the *viśayavākya* of Bra. Sū. I. 1. 2 and in Sūtra I. 3. 1, the words *ānanda* and *āyatana* in *ānandādayaḥ* and *āyatanādayaḥ* can be well identified with the same occurring in the *viśayavākya* of Bra. Sū. I. 1. 2 (or I. 1. 12) and in Sūtra I. 3. 1 respectively, and consequently *ānandadi* and *āyatanādi* would imply the attributes or thoughts (in the Śrutis) collected in Pādas 1 and 3. The word *satya* in *satyādayaḥ*, however, does not occur in Sūtra I. 2. 1, but it occurs as a member of the compound word *satyasaṅkalpa* in the Śruti referred to by that Sūtra. Thus, to my mind, there will be no difficulty in identifying *satya* with *satyasaṅkalpa*, on the analogy of *āyatana* being identified with *dyubhṛvādīyātana*. The name of the *bahuvrīhi* compound '*satyādayaḥ*' seems to have been derived from the word '*satyasaṅkalpa*' in the Śruti referred to. Moreover, the identification of the *first* and the *third* lists (*ānandādayaḥ* in Sūtra III. 3. 11 and *āyatanādayaḥ* in Sūtra III. 3. 39) with those of the thoughts in Bra. Sū. I. 1 and I. 3 itself helps to identify the *second* list (*satyādayaḥ* in Bra. Sū. III. 3. 38—39) with that of the thoughts in Bra. Sū. I. 2.

A detailed explanation of the Sūtras in which *ānandādayaḥ*, *satyādayaḥ* and *āyatanādayaḥ* occur would, I believe, make my suggestion more plausible.

The word *pradhāna* as used in Sūtra III. 3. 11 (*ānandādayaḥ pradhānasya*), no doubt, bears the same significance as in Sūtra III. 2. 14 (*arūpavad eva hi tatpradhānatvāt*) and, again, the word *rūpa* in *arūpavad* in the latter Sūtra bears the same significance as *rūpa* in *rūpopanyāsāc ca* (Bra. Sū. I. 2. 23). *Pradhāna* in Sūtra III. 3. 11, according to Śaṅkara¹, means Brahman. According to the Sūtrakāra

1 One more Sūtra in which the word *pradhāna* is similarly used is Sūtra III. 3. 43 which, though traditionally read as *pradhānavad eva hi tad uktam*, should have originally been *pradhānavad eva hi tad uktam* and *tad uktam* must refer to *itaravat* in *atmagrāhītaravat uttarāt* (Bra. Sū. III. 3, 16 as already suggested by me in my Thesis (Akṣara : A Forgotten Chapter in the History of Indian Philosophy, P. 164.)

the Supreme Being is both *rūpavat* and *arūpavat*, but one may say that "the Supreme Being is only *arūpavat* because that (*arūpavat*) is the chief (aspect in the Supreme Being—Bra. Sū. III. 2. 14)". In Sūtra I. 2. 23 the Sūtrakāra argues that the *adrśyatvādiguṇaka* in Mu. Upa. I. 1. 5—6 is *puruṣa* (or *parameśvara* according to Śaṅkara) "because the form of the *adrśyatvādiguṇaka* is mentioned in that Śruti (Mu. Upa. II. 1. 4)". So, according to the Sūtrakāra *pradhāna* is the *arūpavat* aspect of the Supreme One and the *rūpavat* aspect is called *puruṣa* or *parameśvara*. Therefore, Sūtra III. 3. 11 (*ānandādayaḥ pradhānasya*) means that "the group of attributes beginning with *ānanda* belongs to the chief aspect of the Supreme Being (which is the formless aspect)."

Incidentally it may be noticed that the second Pāda of the first Adhyāya seems to have been meant for discussing certain Śrutis which according to the Sūtrakāra mention the *rūpavat* or *puruṣa* aspect of the Supreme Being. Moreover, Śaṅkara presents a twofold aspect of Brahman, as *saguṇa* and *nirguṇa*, whereas the Sūtrakāra interprets the Supreme Being as *rūpavat* and *arūpavat*, both of which do not exclude the possibility of having attributes of their own.

Regarding Sūtras III. 3.38 (*saiva hi satyadayah*) and III. 3. 39 (*kāmāditratra tatra c āyatanādibhyaḥ*), I have already suggested elsewhere¹ that Sūtra III. 3.38 should read as *saiva hi* and Sūtra III. 3. 39 should have been *satyādayaḥ kāmāditratra tatra c āyatanādibhyaḥ*. The *ī* (long *ī*) in *kāmāditratra* as given in Śaṅkara's Pāṭha is short in Madhva's. The latter reading, thus, strengthens my suggestion with regard to transferring *satyādayaḥ* in Bra. Sū. III, 3. 38 to Bra. Sū. III. 3. 39.

"The group of attributes beginning with *satya* (i. e. *satyasamkalpa*) in Bra. Sū. I. 2 may, according to the choice of the meditator, be taken in the meditation of the other aspect of the Supreme Being (i. e. *arūpavat*, though the Sūtrakāra would like to take them as belonging to the *rūpavat*), and in the meditation of the *rūpavat* should (invariably) be taken the attributes from the group of those beginning with *dyubhāvādyatana* in Bra. Sū. I. 3. 1". This, to my mind is the interpretation of Sūtra III 3. 39.

Thus, the first Pāda contains *ānanda* and other attributes which belong only to the *pradhāna* or *arūpavat* aspect of the Supreme Being. The second Pāda, according to the Sūtrakāra, contains attributes of the *rūpavat* or *puruṣa* aspect; but a meditator has the option to use them in the meditation of the other aspect viz., the *pradhāna* or the *arūpavat*. In the third Pāda the author of the Sūtras has collected such attributes as can be used in the meditation of *puruṣa* only. This

conclusion may justly be adduced from the meaning of Bra. Sū. III. 3, 11 (*ānandādayaḥ pradhānasya*) and III. 3. 39 (*satyādayaḥ kāmād itaratra tatra c' āyatanādibhyaḥ*).

Now, a study of the nature of the Sūtrakāra's arguments and of that of the contents of the *viśayavākya*s in these three Pādas, as given below, will offer further evidence to strengthen my suggestion.

In Pāda 1, the Sūtrakāra's chief argument is that the *viśayavākya*s mention only that characteristic (*dharma* or *liṅga*) of Brahman, which is stated in Bra. Sū. I. 1. 2; and we find that the *viśayavākya*s of that Pāda (except that of Bra. Sū. I. 1. 12) are such as mention one or two or all out of the three functions of Brahman, viz., the creation, continuation and dissolution of the beings, though instead of the word 'Brahman' words like *antaḥ puruṣa*, *ākāśa*, *prāṇa* (Chā. Upa. I. 11. 4-5 and also Kau, Upa. III. 2. 4) and *jyotiḥ* are used in them.

The main argument of the Sūtrakāra in the second Pāda is the mention of the *rūpa* or *guṇas* or *viśeṣaṇas* (of the *puruṣa*) in the *viśayavākya*s, and in one case he even points to the fact that the *vaiśvānara ātman* of the *viśayavākya* is called *puruṣa* in a certain Branch of the Veda (Bra. Sū. I. 2. 26). If we look to the *viśayavākya*s themselves, we find that each of them contains clear unambiguous words like Brahman, Atman instead of words like *ākāśa*, *prāṇa* *jyotiḥ* as in Pāda 1 which do not primarily signify the Supreme Being but the word *puruṣa* does not occur in those *viśayavākya*s.

In the third Pāda the Sūtrakāra often argues that the *viśayavākya* Śruti in question calls the topic of the *viśayavākya* "*puruṣa*". Thus, *muktopasṛpyavyapadeśāt* in Bra. Sū. I. 3. 2 means '*puruṣavyapadeśāt*' because the *muktopasṛpya* in Mu. Upa. III. 2. 8 is no other than *puruṣa*; *ikṣatikarmavyapadeśāt* in Bra. Sū. I. 3. 13 means '*puruṣavyapadeśāt*' because the *ikṣatikarman* in Pra. Upa. V. 5, 7 is *puruṣa*; *śabdād eva* in Bra. Sū. I. 3. 24 refers to the word '*puruṣa*' in the *viśayavākya*; and lastly '*patyādīśabdebhyaḥ*' in Bra. Sū. I. 3. 43 shows that the Sūtrakāra emphasises the use of the words *Patī*, *Īśvara* etc. in the Śrutis, which are synonyms of *puruṣa* and not of the *arūpa*-*vat* aspect of the Supreme Being.

The Śrutis also, discussed in Bra. Sū. I. 3, are such as mention the word *puruṣa* or some attribute like *dhṛti*, *praśāsana*, which can only belong to the personal aspect of the Supreme Being. In the latter type of Śrutis, instead of the word *puruṣa*, a word like Brahman or Atman occurs in the *viśayavākya*s.

Thus, generally speaking, the main point of argument in the three Pādas is respectively (1) the statement about the creation, continuation or merging of beings into the Supreme One in the

viṣayavākyaś, (2) the mention of *guṇas* or *viśeṣaṇas* of the Puruṣa in the *viṣayavākyaś*, and (3) the occurrence of the word Puruṣa or of some of his exclusive attributes in the *viṣayavākyaś*. The *viṣayavākyaś* Śrutis in the three Pādas are respectively (1) such as mention a word other than Brahman or Puruṣa, (2) such as mention the word Brahman or Ātman and (3) such as mention the very word Puruṣa or one of his exclusive attributes in case a word expressive of the *arūpavat* is mentioned in the Śruti. In my opinion the three lines of argument as adopted by the Sūtrakāra and the contents of the *viṣayavākyaś* in the first three Pādas of the first Adhyāya show that these Pādas are respectively aimed at discussing (1) only the *arūpavat* (2) the optionally *rūpavat* and (3) the only *rūpavat* aspect of the Supreme Being.

I do admit the fact that one may find it difficult to explain away some of the Sūtras and the *viṣayavākyaś* of Bra. Sū. I.1-3 in the light of the above analysis of the general line of the Sūtrakāra's arguments and of the nature of the selected Śrutis, but broadly speaking, in spite of such difficulties, that analysis seems to me to be correct and I, therefore, venture to offer it for the consideration of the students of the subject.

The above conclusion is arrived at as a result of (1) the identification of the three sets of attributes (*ānandādayaḥ*, *satyādayaḥ*, and *āyatanādayaḥ*) with the attributes collected by the Sūtrakāra in the first three Pādas of the first Adhyāya of Brahma sūtras, (2) the interpretation of Sūtras III. 3. 11, 38—39, (3) the analysis of the nature of the Sūtrakāra's arguments in Bra. Sū. I. 1—3, and (4) of the contents of the *viṣayavākyaś* in Bra. Sū. I. 1—3.

If the above interpretation be accepted, it is possible to explain several other problems regarding that part of the Sūtras : e.g. (1) Why are the Śrutis with the same word not discussed in the same place in the same Pāda? One *jyotiḥ* Śruti is discussed in Bra. Sū. I. 1. 24, while another in Bra. Sū. I. 3. 40; one *ākāśa* Śruti is discussed in Bra. Sū. I. 1. 22 while another in Br. Sū. I. 3. 41; two *prāṇa* Śrutis are discussed in Bra. Sū. I. 1. 23 and 28, while one more in Bra. Sū. I. 3. 39. Why so? (2) Why are the Śrutis of the same Upaniṣad not grouped together for discussion in Bra. Sū. I. 1—3? (3) If the Sūtrakāra simply wanted to show that *all* the Śrutis he discussed refer to one and the same (aspect of) Brahman, why he did it in three separate Pādas instead of in one long continued Pāda or Adhyāya? Or, at least, why did he not make all the three Pādas equal? (4) How is it that many Śrutis which hardly seem to require any discussion have been taken up for discussion by the Sūtrakāra? Thus, for example, Br. Upa. III. 7. 1—2, Mu. Upa. I. 1. 5—6, Mu. Upa. II. 2. 5, Chā. Upa. VII. 23—24, Br. Upa. III. 8. 7—8,

are very clear and yet they are selected for discussion. The *pūrvapakṣa* views given by Śaṅkarācārya in the case of these Śrutis seem to be *prima facie* impossible if we look to *viśayavākya*s themselves. And (5) Why is it that Śrutis like Mu. Upa. I. 1. 5—6, Br. Upa. III. 8. 7—8, which in his commentary on the respective Upaniṣads Śaṅkarācārya interprets as treating of the *nirguṇa* Brahman of his school, have to be interpreted by him in the Brahmasūtras as dealing with the *saguṇa* Parameśvara of his own school?

Before closing this paper it will not be out of place to briefly notice the views of some of the Ācāryas regarding the subject of this article. (1) Śaṅkarācārya says that the first Pāda discusses the Śrutis in which the characteristics of Brahman are *clear*, while the second and the third Pādas deal with Śrutis which have *ambiguous* statements of the characteristics of Brahman (Vide Śā. Bhā. on Bra. Sū. I. 2. 1). This view is contradicted by the discussion, in each of these three Pādas, of certain Śrutis which, according to the Sūtrakāra, have given rise to doubts about a Smārta principle (the Sāṃkhya *pradhāna* according to the commentators) or the individual soul being their topic, while each of them discusses some Śrutis without presupposing any such doubt at all. (2) The Bhāmatikāra, the author of the Ratnaprabhā and Ānandagiri (Vide their introductions to Bra. Sū. I. 3) say that the Śrutis about the *upāsya* or *saguṇa* Brahman and those about the *jñeya* or *nirguṇa* Brahman are discussed respectively in the second and the third Pādas of the first Adhyāya. This position can be also refuted by the fact that the Sūtrakāra in both these Pādas clearly emphasises the mention of the *guṇas* or *dharma*s of the Supreme Being in the *viśayavākya*s and that he discusses the so-called *nirguṇabrahmapara viśayavākya*s in *both* these Pādas (Vide the Śrutis discussed in Bra. Sū. I. 2. 21., I. 3 10). (3) According to Rāmānuja the first Pāda discusses those Śrutis which clearly mention *only* Brahman, the second those which also contain *obscure* indications of the individual soul etc. (*aspaṣṭaṅga-vādīṅgakāni vākyaṇi*) and the third Pāda those which contain *clear* indications about the *jīva* etc. *spaṣṭaṅgakāni vākyaṇi*—See Rāmānuja's comm. on Bra. Sū. I. 2. 1.). This seems to me to be one of Rāmānuja's ways of criticising the interpretation of the Śāṅkara School Commentators and he does not explain what are obscure or clear indications of the individual soul or matter, and how it is that certain *viśayavākya*s in all these Pādas do not admit of any *pūrvapakṣa* views about either *jīva* or *jada* (Vide Rāmānuja's comm. on Bra. Sū. I. 2. 1.) (4). Vallabha severely finds fault with the Śāṅkara School for holding that Brahman can have any *guṇas* like those of the Sāṃkhya School. In his opinion the first Pāda removes doubts arising from *śabda* or terms of the *viśayavākya*s, while Pādas

2 and 3, the ambiguities of Śrutis arising out of their meaning or *artha*. But this view is also equally untenable because Pāda 1 and also 3 discuss Śrutis in which words like *ākāśa*, *jyotiḥ*, *prāṇa* are used instead of the unambiguous terms, Brahman or Ātman (Vide Bra. Sū. I. 1. 22, 23, 24 and 1. 3. 39, 40, 41). Vallabha's further statement that the second Pāda deals with such Śrutis as predominantly use words which mean *jīva* while the third Pāda with those which make similar use of words which mean *jada* (Vide Aṇubhāṣya on Bra. Sū. I. 2. 1) is apparently a modification of Ramānuj's view and my criticism of Ramānuja's view equally applies to it also. None of these Ācāryas supports his view on the strength of any Sūtra of the text ; and, as I have tried to show, the Sūtras seem to support none of their views. Looking to the position of the commentators I am, therefore, all the more convinced about the truth of the conclusion I have arrived at in this paper regarding the scheme of the discussion of Śrutis in Bra. Sū. I. 1-3.

P. M. MODI.

Reviews

The Mahābhārata. Analysis and Index BY EDWARD P. RICE.
Oxford University Press. 1934. Pp. xvi+112. (Price Rs. 5.)

"The Mahābhārata," as has been well said, "occupies a central position in the literature of India, not only because it is held by the Hindus to be one of their most sacred books, but also because it contains the old traditions of ancient Brahmanical India in a more popular form, and is the source from which the ideas of the actual Purāṇas and modern Hinduism may be derived, representing as it does, as far as we at present know, the oldest form of these ideas."

There was, therefore, undoubtedly a need for an Analysis and Index, in English, of the Mahābhārata, and Mr. Rice's little book is an opportune publication (when the Mahābhārata is once again attracting the attention of the cultured citizen of the world) and a welcome addition to the literature on the Mahābhārata.

Mr. Rice's Analysis is a summary—a very brief summary—of the Great Epic, following the original chapter by chapter. The Mahābhārata has often been described—quite justly—as a 'jungle' of information. "What has been needed," writes Mr. Rice in the Preface, "is a *map* of this jungle—a plan of paths and byways through it, which shall make its contents easily accessible." Mr. Rice's Analysis is an attempt to meet this need. And we may say that Mr. Rice has succeeded admirably in giving us a contour map of the Great Epic.

The Analysis is followed by two Indices: an Index of Names (pp. 85–104 and an Index of Subjects (pp. 105–112). Sørensen's elaborate *Index to the Names in the Mahābhārata* (London, 1925) is utterly out of the reach of the ordinary Indian scholar, who is, notoriously, poor as a church mouse, its price being nearly £5. Mr. Rice's Index, which is of very modest dimensions, will admirably serve the purpose of the ordinary reader.

This is probably the first time that an Index of subjects dealt with in the Mahābhārata has been published in English, the only other Index of that kind known to me being Jacobi's "Kurzes Sachregister" (appended to his *Inhaltsangabe*, Berlin 1903), which is, however, a sealed book to the average Indian student.

Mr. Rice's Index is a little more detailed and in some ways may be said to be an improvement on that of Jacobi, who has contented

himself with giving bare indications. We hope it will pave the way to the preparation of a much more detailed and elaborate subject-index of the Mahābhārata.

Mr. Rice's booklet contains some slight mistakes in the spelling of Sanskrit words (which are rather difficult for a foreigner to manage), and other inaccuracies; but it would be deemed captious to point them out here, because the work is not written primarily for the use of the scholar. Mr. Rice has intended it for a wider circle of readers, dedicating it to "all who are interested in India's age-long religious quest and who toil and hope for her brighter future." He has a higher and nobler aim than mere serving the needs of the specialist: a Fellowship and Synthesis of Culture. In Mr. Rice's own words, his aim is to "prepare the way for that day for which many hope, when, by fuller knowledge of other peoples, and by mutual sympathy and goodwill, all differing symbolisms, theories, mythologies and aspirations, which in past centuries have been helpful to peoples in widely separated portions of the globe, may find their reconciliation in a unanimity of religious ideals, which shall transcend all those hitherto current, and command acceptance from the conscience of universal man." To that we can only say "Amen" !

V. S. S.

The Story of Kālaka ; Texts, History, Legends, and Miniature Paintings of Śvetāmbara Jain Hagiographical work—The Kālakācāryakathā : BY W. NORMAN BROWN, Professor of Sanskrit, in the University of Pennsylvania. Published by the Smithsonian Institute, Freer Gallery of Art, Washington, 1933.

Professor Brown has done a distinct service to Jain literature by bringing together and carefully sifting a very large amount of valuable material, connected with the story of Kālaka. Kālakācārya is a distinguished monk of Jainism, whose name is invariably associated with the transfer of the Paryuṣṇā Parvan from the 5th to the 4th day of the month of Bhādrapada. It appears that the story of this Ācārya was originally told in connection with this important event and it is not without significance, that even to-day it 'is to be read with the Kalpasūtra on the first night of the Paryuṣṇā' (p. 2). In the beginning, the story must have been a simple one, narrating only the event of the 'Transfer of the date', but very naturally, in course of time, there must have grown around this Savant, who brought about

this important change, a semi-historical tradition alluding to a few events of his life, to serve as a brilliant back-ground for this wonderful exploit. It is again no wonder, if, in order to add to the brilliance of this back-ground, the Tradition also appropriated the glorious happenings of the earlier Savants of Jainism, bearing the name of Kālakācārya, and formed a picturesque whole, so as to suit the requirements of the case i.e. 'the strengthening of the Faith of the Believers'.

Professor Brown thinks that the episode 'dealing with the change of the Paryuṣṇā date was the last to be included in the cycle, for it is the only one that is never illustrated by paintings in the MSS.' (p. 3). This may be true in a restricted sense, but I believe, it is this episode, which formed the nucleus of the present Story of Kālakācārya. 'The formation of the story began *with it* and the other episodes were added on to it only later, to lend colour to the story. The story-teller, being anxious to prove the 'worthiness of his hero, to effect the important change of the date, must have prefixed to this central event, a story illustrative of the personal valour, skill and political wisdom of his hero, and after thus establishing his point, he must have added some other events like the preaching of the Nigoda doctrine to Śakra, to corroborate it. It is easy to understand, on this assumption, why a 5th episode of the hero's wicked nephew Datta, who 'plans his death, but himself is humiliated and dies fearsomely' is added by some story-tellers and why the 3rd and the 4th episodes are dropped from the story, by another one. Evidently, a few years after the death of the great Kālakasūri, who introduced the change of the date in Sam. 523, the practice of telling the story of how the date was transferred, at the time of the Festival, must have been started, first as a sort of reminder of the great Authority which had sanctioned the transfer of the date and later, merely as a matter of routine. Then in course of time, probably in the 7th or the 8th century, the whole story must have been pieced up together as it is at present. We find references to the story in its new form in the earliest Prakrit commentaries, called Cūrṇis, on the Sūtras (p. 4). Of the three Kālakas known to Tradition, the first is sometimes credited with the transfer of the date in the 2nd century B. C. (p. 7), but this is obviously an attempt to show that the practice of celebrating the festival on 4th day dates from very old times.

Professor Brown has considered 17 different versions of the Story of Kālaka, arranging them under five groups, of which the first includes 10, the second contains 2, the third has only 1, the fourth contains 3, while the fifth has again only one version in it. 8 of these 17 are written in Sanskrit, while the others are written in

Prakrit. 8 again (4 Sanskrit and 4 Prakrit) are found usually given at the end of the MSS. of the Kalpasūtra, while the remaining 9 have the appearance of being composed independantly, though all recognize the importance of the central episode i.e. the change of the date. All the versions again, naturally assign a comparatively large portion of the narrative to the introductory episode of the overthrow of King Gardabhilla, as it serves to show the great courage and sagacity of the hero, and also because a moral lesson has to be conveyed that even a wicked act may be glorified, if it is done for the sole purpose of the propagation of the Faith. (p. 2). The earliest of these 17 versions is earlier than Sarṇ. 1336 and the latest one was composed in Sarṇ. 1666 by Samayasundaragaṇi of the Kharatara Gaccha. Professor Brown has edited two of these, i.e. the 'long anonymous' and the 'Hayapaḍiṇiya' with English translation and few critical notes. Three others, namely those of Bhāvadeva and Dharmaprabha Sūris, and the Sriviravākyānumata' version, are merely edited (pp. 87-101), while one, i.e. that of Bhadreśvarasūri, is edited with an analysis in English (pp. 102-107). The Lexical notes added at the end (pp. 108-111) are bound to be very useful. Chapter II again is a very useful addition to our knowledge of the History of the early miniature paintings in the Western India. Students of Jainism will surely feel indebted to Professor Brown for his 'Story of Kālaka', though 'the newly examined versions of the Kālaka legends add nothing' new on the vexatious question of the origin of the Śaka and the Sarṇvat eras (p. 11).

We now proceed to corroborate or amplify a few statements made by the editor in his book :—

P. 4, LL. 19-20. The author says that the Devendra who commented upon the Praśnottararatnamālā in Sarṇ 1429 is not the same as the Devendra who wrote his commentary on the Uttarādhyana-sūtra in Sarṇ. 1129. This is right. The former Devendra belonged to the Rudrapalliya Gaccha and was the pupil of Saṅghatilakasūri, while the latter belonged to the Bṛhad Gaccha and was the pupil of Āmradevasūri. The second Devendra was besides, only a Devendraganin and was called Nemicantrasūri after his Dikṣa as a Sādhu; cf. Bhandarkar, Reports, IV. p. 129.

P. 7, ll. 16ff. The Jain astronomer mentioned by Bhaṭṭa Utpala in his commentary on Bṛhad Jātaka, ch. XV. v. 1 (vol. XV. p. 1 is obviously a misprint) is really a Baṛṇkālākācārya and not a Kālākācārya. The wrong impression first created by Bühler, who proposed to read 'tathācāivam Kālākācāryah' for 'tathā ca Varṇkālākācāryah' (cf. I. A. vol. 20, p. 362) does not yet appear to have been wholly removed, though Aufrecht in his Catalogus Catalogorum,

I. p. 548, still regards the name to be Vamkālākācārya. Like Prof. Brown, I too doubted the propriety of Bühler's emendation, since *evam* coming after *tathā ca* to introduce an authority is very unusual. Now, a reference to the actual passage leaves no doubt whatsoever that the name is Varṅkālākācārya (or Baiṅkālākācārya as my MS. reads), and not Kālākācārya as is supposed so far. The passage in question runs thus :— (from MS. no. 367 of the BBRAS., Collection ; cf. my Descrip. Cata. p. 121). एवं क्रमात् प्रव्रज्यापर्याया : । एते बंकालकमताद्व्याख्याताः । तथा च बंकालकाचार्यैः—

तावसिओ दिण्णाहे, चंदे कावालिओ तहा भणिओ ।

रत्तवडो भूमिसुए सोमसुए एअदंडीओ ॥

देवगुरुसुक्कोणा कमेण जइचरअखवणाई ॥

In the commentary on the same stanza, we also find another reference to the Baiṅkālaka Saṁhitā :—

तथाच बंकालकसांहितान्तरं पठयते—

जलणहरासुगअकेसअसूरिअबंभणगमग्गेसु ।

दिक्खाणं णाअव्वा सूरुइगहा कमेण णाहगआ ॥

These two quotations ought to leave no doubt that Utpala quotes a Baiṅkālākācārya and not a Kālākācārya at all. Evidently, this Baiṅkālaka is a Jain writer as the language shows. He may perhaps be Bhadrabāhu, but this is merely a conjecture. The difficulty will be solved if the quotations given above are traced anywhere. I may suggest in passing, that the name Kālaka was only a nick-name in the case of Kālaka I, who was also known as Śyāmārya, given him on account of his extremely dark complexion. In the case of the other two it may not have been so.

P. 30, L. 8. read saṅksiptarucihetave and not saṅksiptam sūcihetave.

P. 31, LL. 1-2. read :—

sridhārāvāsam ityasti nagaram na garo jayī

dvijihvāsyasamudgīrṇo yatra sādhuvaomṛtaiḥ.

Translate :—There was a city called Dhārāvāsa, where the venom (garo) thrown out by the mouths of the dvijihvas (i. e. serpents or villains) was never successful, on account of the existence of the nectar in the form of the words of the wise.

P. 31. L. 4. read āśāskambhāvalambādyā, i. e. rich on account of the support of the pillar (skambha) of the quarters.

P. 31, L. 29. read ittham kālikasūrīrājacaritam &c.

P. 33, LL. 3-4 from the bottom. read the two lines as follows :—

kappaṇisīhakahāvalipabhiyaṇusāreṇa iya mahāisayā.

kālayasūripa (not-e) bandhā vaḍḍhā vi (sayā) suṇantu muṇī,

Lastly we come to the enigmatic stanza no. 19 on p. 94. Professor Brown thinks that it is a stanza in the Prakrit language. This however, does not seem probable as it is introduced by a sentence in Sanskrit, i. e. *yatra ca var-āgame*. It is clear that it contains the description of rainy season, but nobody can be sure as to its real meaning. The following meaning is arrived at with the help of the *Ekākāra Kośa* in particular. I was materially helped by my friend Pandit Shintre Shastri of the Elphinstone College in getting at it.

Prose construction :- *सिरिरंसुसूरः असूरो (भवति) । सरसी असा ऊसरा (च) (जायते) । सासारा असु-सारासा रसा सुसारसासरं सरिं आस । ('सः कोपे वरणे सः स्यात्' । 'साच लक्ष्मीर्बुधैः प्रोक्ता' । उकारश्चापि 'लक्षणे' ।- ए० को०) सःकामः अस्यास्तीति सी । ऊं लक्षणं सरतीति ऊसरा । सुसारसं सरतीति तां सुसारसासरम्*

Translation :—A brave man (*sūrah*) becomes not brave (*asūrah*), being struck with passion and therefore desirous of sporting with his wife (*siriraṁsu*); the lake loses its clearness (*asā*) and obtains its natural characteristic, i. e. flowing in a stream (*ūsarā*). The earth (*rasā*), being associated with the showers (*sāsārā*) robs the vital breath of its power (*asusārāsā*) and brings forth a stream of water (*sarim*), which is attended by beautiful lotuses (*susārasāsaram*).

H. D. VELANKAR.

Sri Kundakundācārya's Pravacanasāra: The Prakrit text critically edited with the Sanskrit commentaries of Amṛtacandra and Jaysena and a Hindi commentary of Pāṇḍe Hemarāja, with an English translation of the text &c. by A. N. UPADHYE, M.A., Professor of Ardhamagadhi, Rajaram College, Kolhapur and published by SHETHA MANILAL REVASHANKAR JHAVERI for the Parama-śruta-prabhāvaka-manḍaḷa, Bombay, 1935. Price Rupees five.

The abovementioned edition of the *Pravacanasāra* will be enthusiastically welcomed by the lovers of Jainism everywhere. It contains the two well-known Sanskrit commentaries of Amṛtacandra and Jayasena, as also the Hindi explanation of Hemarāj Paṇḍe and a literal English translation by the editor given at the end. The introduction is a very exhaustive one and fully deals with all the questions connected with the date and the works of *Sri Kundakunda*, the philosophical and monastic aspects of the *Pravacanasāra*, its

different commentators and the Prakrit dialect in which it is written. One cannot but be impressed by the thoroughly methodical treatment of every topic by the editor, though his remarks on the 'Text of the Pravacanasāra' on pp. L-LIV, are not so very convincing. The conclusion which he draws regarding the genuineness of the additional stanzas on p. LII (LL. 9-11) is not sufficiently borne out by what is said in the following paragraphs. He again keeps us in the dark as regards the MSS. material on which he bases his text of the Pravacanasāra. Apparently, he has not consulted any MSS, for this purpose, except the two, the variant readings from which he gives at the end (p. 42ff), and it is not his aim to give us a 'critical text of the Pravacanasāra without any bias for a particular commentator' (cf. p. 42), in the present edition. But for this defect, the edition is an excellent one and is bound to be extremely helpful in the study of Śrī Kundakunda and his Pravacanasāra, both on account of the wealth of information which it contains and the thought-provoking observations of the editor, which show his deep study and patient research.

H. D. VELANKAR.

The Bhagavadgītā with eleven commentaries (First Collection), vol. I, (Adhys. 1-6), New edition (2nd), critically edited and thoroughly revised by SHASTRI GAJANANA SHAMBHU SADHALE and published by the Proprietors of the Gujarati Printing Press, at Bombay, 1935.

We most heartily congratulate the proprietors of the Gujarati Printing Press on this *second edition* of their 'First Collection' of valuable and rare commentaries on the most popular Vedantic work, the Bhagavadgītā, which is rightly regarded as the guiding star of a Hindu's spiritual and moral life. They have as a matter of fact, concentrated their energies on this enterprise and have so far given us about 20 neatly printed and carefully edited commentaries of high literary and philosophical value, in the two Gucchas together. The abovementioned second edition of the first Guccha contains the Bhāṣyas of the four great Ācārayas representing the principal schools of the Vedānta, together with a lucid commentary on each of them. It also contains the Paiśāca Bhāṣya ascribed to Hanūmat by Tradition, and the Brahmanāndagiri, a highly learned commentary of the Śāṅkara school composed by Venkaṭanātha, as also the Bhārata-bhāva-

dīpa of Nilakaṇṭha. At the end of each chapter, the learned 'Vidyā-larṇkāra' Dhupakar Shastri of Goa has added his brief notes (called Avigītā), which contain on the one hand, a criticism of a few points of discussion raised by the old and new commentators including the Gītārahasya of the late Lokamanya, and on the other, a Sanskrit rendering of some interesting portions of the older Marāṭhī commentaries written by Jñāneśvara and Vāmana Paṇḍita.

The editor of the work, Pandit Gajanana Shastri Sadhale has devoted utmost care and patience to his task, as will be evident from the numberless references occurring in the different commentaries, which are traced by him to their original sources. This was a very difficult task, but we are glad to note, that it has been executed with great success by the learned editor. The edition indeed offers great facilities for a comparative and critical study of the exegetical material connected with the Bhagvadgita, and we strongly recommend it to all lovers of the Gītā. We earnestly hope that the remaining parts of it will soon be out, not excluding the one, in which the publishers propose to give 'the different kinds of proper indexes' without which the work is bound to remain incomplete.

H. D. VELANKAR.

ART AND MORALITY*

The man who teaches, says the author in his preface, is normally seized with the desire to write. "It is easier for a teacher than for anyone else, sooner or later, to perpetrate the crime of authorship." This is intended to explain the genesis of the book. It consists of a number of articles which either saw the light of day in journals or were originally read as papers before various associations. The subjects covered by these articles range over a wide field from the relation of art and morality to Dante and Goethe on the one hand and to the Gita and Firdausi on the other. They also include subjects like forms of divination and Ibsen on marriage. They are indicative of the wide range of interests and also the culture and reading of the author. He belongs to a family with traditions of culture. It is refreshing to find that one who is associated with the teaching of English literature should also be fairly conversant with Classics like the Shahnameh

* Art and Morality and other essays by F. C. Davar, M. A. LL.B. (D. B. Taraporewala, Sons, Rs. 5)

and the Gita and also have an intimate acquaintance with Gujarati literature. Wideness of outlook and a cultural background which includes a knowledge of the classics of the East and West alike must be necessarily welcomed in an age of specialisation, when the tendency is too often to overemphasise the value of one's own narrow field of interest and study. Every one of the chapters that make up this book affords ample evidence of such width of interest in the writer.

There is not much in the shape of originality of thinking or creative work, nor does one expect these, in a volume of this kind; there are evidences also of somewhat crude and immature thinking on some of the sociological problems on which the author has dwelt. But there is an honest attempt throughout at being impartial in the representation of opposite schools of thinking as in the article on art and morality, as also on Ibsen and the sanctity of marriage. Above all in the treatment of all these subjects connected with art and literature we trace the presence of a serious, earnest, God-directed soul, that humbly endeavours to obtain such glimpses as it can into the working of the divine purpose in the drama of History and the variegated Universe of life and manners that surrounds us.

P. A. W.

Indo-Aryan Literature and Culture. (Origins). By Prof. N. N. GHOSH. Published by The Book Company Calcutta, 1934.

I

(A Brief Criticism)

Students of ancient Indian History are more and more veering round to this view : that a number of successive racial intrusions into, and occupations of India have contributed to the elements now found in the Hindu religion and Society which took final form as the result of the impact of the social ascendancy of the Indo-European invaders of the second millenium B. C. on the pre-existing religious institutions. It may again be easily granted that the manner of spread of Brahmanism was (a) absorption of tribal religions in virtue of its social prestige; (b) identifying local gods with its own; and (c) social promotion of pagan chiefs by providing suitable mythological pedigrees.

Mr. Ghosh has, at least so far as larger outlines of his conclusions are concerned, reached identical results by methods all his own.

Q

The central thesis, stated succinctly in the preface, summarised in the synopsis of contents and expounded in the fourteen sections in which the book is divided is as follows: "That the Indo-Aryan literature-cum-culture is not the single-lined metabolic evolution it is generally believed to be, of a pure-blooded Aryan organism; that any Indo-Aryan history that seeks to trace the whole movement ultimately from a single vegetative source and to explain it all in terms of the evolution and involution of the same stock of energy cannot really represent history as it happened; that on the other hand it is a synthetic product whereof the material elements were in the main of Non-Aryan origin; that nevertheless it was the highly educated Aryan brain and the organising Aryan genius which play the determinative part in giving that product the shape and directions it is seen to have taken".

There are two ways in which a critical sifting of the contents of this book can be made, one is to take any part of the Indo-Aryan literature or culture and see how the author explains its origins—for that is the job before him. The other way is to study the hypothesis, the method of stringing the data around it and the extent and value of the perspective thus formed towards Indo-Aryan literature and culture. It is necessary to bear in mind that the origins are located at no particular point of time and that the aim before the author is to reconstruct and watch the inter-play of forces and circumstances of which were born the literature and culture of the Indo-Aryans. His is the history from a long perspective.

To come now to details of his argument to whose conclusions one may say, ready assent can be given at least in the larger outlines. He starts with the existence of two civilizations in two parts of India—the Punjab and the Gangetic plain. The Punjab contains scattered Aryan settlements before whom, among others, two political problems exist—one is the necessity of adding to the man-power of the settlements for needs of self-preservation (by defence or aggression) and is solved through the invention of the "conversion Vratyastoma"; the second is of internal peace—the strife being the result of clash of ambitions of the Kshatriya and the Brahmana (both were office-holders then) for social leadership of the settlements. The way this problem was solved by one of the parties concerned forms the central fact of Indo-Aryan history in the opinion of the author. The political problem of the other area was a minor one—the bulk of the inhabitants being extremely docile—viz., the frontier defence on the western boundary of the empire. The difference between the two civilizations lay not only in the nature of their political problems but also in sharp contrasts with reference to beliefs and practices and

above all in the compositions of populations. One final point: the eastern civilization was stable, had a political centre of gravity and plenty of roads: the other was a shifting one, had a number of political units and little or no roads.

While the "conversion Vratya-stoma" solved the first political difficulty of the Aryan Settlements, the second got accentuated as time went on, and there was a "purge"—some Brahmins left the settlements—in protest or in exile or on travel! They went eastwards towards the Vṛātya Empire consisting of the Anūpadesa and Magadha. The author assumes a series of lucky events in the travels of these dissatisfied Brahmins. They escaped one feels, the Dasyus and the tiger and reach the Vṛātya capital, are able to find audience with the Emperor, who, a great philosopher and diplomat again is very kind to them and in whose favour they soon manage to wriggle themselves and supersede their native rivals. Not that alone. A concordat is struck between the Emperor and the alien Brahmin Aryans to the effect that the frontier troubles of the former were to be solved by the latter's political propaganda on his behalf in the Aryan Settlements, and for this work, getting a reward of social leadership in matters of religion in his Empire. And what was the result of all this? "The whole population of this extensive area.....become as though at one stroke, an Aryan viś and the whole country was transformed into a part and much the greater part indeed of Arya-varta so that the centre of gravity of this Neo-Aryanism all at once swung to the East". (p. 39).

A careful consideration of the *mode* of contact of these two civilizations detailed above seems to suggest on the one hand, that "the law of parsimony in imagination" is not observed; and on the other that neither were the two civilizations "diametrically contrasted" nor, in the sequence of circumstances could the meeting together of the best elements in them both, stand first, much less as the result of dissatisfaction between persons holding two types of offices.

In fact: (1) Even if variety is the characteristic of the eastern population, it cannot be absent in the West where lay scattered settlements not joined by roads. (The author seems to assume this in some places (pp. 183, 186). (2) The region of contact and admixture of cultures will be most conveniently the area formed by the most eastern portion of the Aryan Settlements and the most Western parts of the Vṛātya-Empire; e. g. "Aryan dominated if not Aryan Land" (p. 135). (3) While riverine basins offered stable material foundation to large kingdoms, it may be observed that large king-

doms could not be entirely unfamiliar to the people in the Panchanad or that an empire continuously existed in the East. (4) I am, therefore, tempted to feel that such impact as came about between the civilizations was not due to any spasmodically mobile elements in the Western Political area reaching the Political centre of the Eastern, but one due to mixing of populations on their fringes in their day-to-day life. The use of this impact—experience, for purposes of literature and distillations called cultural ideas, required intelligence and patronage, which could be supposed to have been concentrated for purposes of co-operation to this end, in the political centres of the day—not necessarily the Vratya ones alone much less Giri-vraja. To take only two polities, to assert no past contact between them (p. 153) before the shuttle-like passage of some people from one of them to the other, and to explain the origins of the Indo-Aryan literature and culture as being due to, and therefore consequent to such passing to and fro of the Brahmins, is to retrench most of what must have happened, i. e. Literature—despite paleontology!—as source of history has this serious short-coming viz. it represents its age idealized—so that if one circumstance is recorded, it would be necessary to consider the possibility of many more similar cases differing only in details from the recorded one, as well as some dissimilar formations. Further, the two polities mentioned could never have been in equilibrium with one another and there are at least equal chances that the source of disturbing influences could have been in the more Eastern of the two.

II

How then would you analyse the persuasive force of the author's arguments? It is due partly to the literary charm of his style, an especial strength being humour (a few good illustrations are on pp. 13, 76, 157 and 179), partly to the fact that repetition is a generator of emphasis, partly because of the brilliant use of the Vratya material and very largely because thought is built on sound commonsense with which one can agree without necessarily sticking to the Brahmin-came-to-the-Vratya—court assumption.

After explaining his view of contact-formation between the two civilizations in the first nine sections, in the next five the author proceeds to state how, in his opinion, the various parts of Indo-Aryan literature and culture came into existence, specifically, as results of this contact. The Brahmin-Vratya association is made to explain Indo-Aryan literature and culture by the aid of two assumptions; first, that the Brahmins whom Mr. Ghosh sends to the Vratya capital are extremely clever and behave there almost as if they were under the guidance of some person like him; and second, "a most extra-

ordinary concatenation of events" (p. 121) followed as a consequence of this association.

The Brahmins at the Vratya court sucked sponge-fashion all the esoteric information of the Rajanya, which before that time used to be kept strictly secret. This information emerged later via the Atharva Veda as Upanishads. The Atharva-veda itself was a "*vade mecum* of the Aryan priests officiating in the Vratya land"; "it had to be Aryan and non-Aryan in different degrees and portions"; and hence its heterogeneous character. The Atharva Veda illustrated and encouraged a habit of "rishification"; led to a repercussion, the end-product of which was a "redaction-renascence" movement in the shape of the Trayi with the Puranas as by-products. The Trayi as literary collection came into existence largely as a reaction of the doings of the Vratya Brahmins "on the minds of the Panchanad Brahmins: Aryan goods got appreciated in value and also had to be labelled differently and apart from the Vratya stuff. The Puranas were concessions of Brahmin intelligence to Vratya patronage and contained "rishified," "the originally transmitted sage-stuff concerning Eastern Vratya Royalties."

Such an explanation possesses the advantage of unity. As is discussed above, however, it is vitiated to the extent the claim that the Aryan and Vratya civilizations came into contact in the Vratya capital—is faulty.

The process of writing a book on social history even in modern times, consists of (a) unrecorded facts existing together in life, (b) retaining in memory observations about them and (c) putting finally on paper all this in writing. Mr. Ghosh finds it necessary—and quite correctly—to distinguish similar stages in the evolution of Indo-Aryan literature: "(i) a 'Smarta' stage; (ii) an oral 'Srauta' stage; and (iii) a 'written Srauta' stage". Again, it may easily be granted that some sort of impetus is necessary for transition from one stage to the next. We are told that this impetus was "external" and that too in the territorial sense of the word, the territory being the Vratya region. Such a view—is a consequence of the hypothesis that empire-making was the monopoly of the Gangetic basin and the overlooking of the possibility of conjunction of patronage and intelligence in the West.

The author has devoted greater space to the origins of literature than of culture. With reference to the latter, the Brahmins once again stand in the position of exhibitionists of pure Vratya stuff—this time, of the social divisions in the Vratya society. The adherence to these divisions by the Brahmins made them luminous by the Brahmin attempt to explain and defend them—incidentally furnishing to posterity the first records of that perplexing institution, caste.

The *origin* of caste? Who can tell that? Not the Brahmins—who found it (and had to adapt themselves to it) ready-made when they tumbled into the Vratya land. Caste as a factor in Indo-Aryan culture was only the then existing divisions of society in Vratya land painted with some Aryan veneer. The Vratya divisions got emphasized as a result of the Brahmin coming on the Scene. The Brahmin flux towards the Vratya capital could be aptly compared to the movement of paint, concrete and bricks into a building already standing.

I think that nowhere else are the weaknesses of the major assumption that the "Brahmin came to the Vratya court and all this followed" better illustrated than in the present one. For this reason: the spread of the Aryan veneer is made consistent with this assumption only with the aid of three further assumptions regarding whom doubts can be entertained easily. They are: (1) that the political head of the Vratya polity was almost a dictator with supreme powers, (2) that the people there were extremely docile; and finally (3) that there existed in that country almost telegraphic communications and means of rapid transport. So that once the despot could be made to give the lead (the bait offered was tranquillity and expansion on the Western frontier) to pretend to be Aryan, the docility of the people and the facility of travel could be trusted to do the trick for the whole extensive area, "almost at one stroke"!

In the brief compass of a few paragraphs it is impossible to do justice to the other historical and sociological excursions as well as the numerous suggestive remarks in this an altogether thought-provoking book. It was necessary to place the Aryan entry into India "nearer to 1500 B.C. than to 2000 B.C.," (p. 245) so as to be able to make Emperor Ashoka a "Successor" to the Vratya Emperor who had the unique fortune of entertaining those clever Aryan Brahmins. It is delightful to see the author throwing away large chunks of the Mahabharata to reach at history, which, again, is explained in terms of a struggle between an internally divided republican order of the west and empire-making in the East.

One lays down the book with the feeling that order can be put in place of chaos at one critical chapter in the ancient history of this country. The chief emotion is of gratitude for a forcible and eloquent exposition of the view that the non-Aryan contribution to Indian culture is far greater than it was the fashion to assume some time ago. The unity of outlook is, definitely, part of the secret of the book's appeal. It is perhaps the more legitimate to point out that the reader is under no compulsion to swallow the menu as a whole, but is at liberty to dine *a la carte*!

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[PART IV

THE ORIGIN OF THE PALLAVAS

INTRODUCTION

One of the most controversial aspects of South Indian history is the still unsolved question of the origin of the Pallavas. The importance of this Dynasty in the cultural history of India is so great that the question of their origin is of no ordinary interest.

The theories hitherto propounded are the following :—

1. The Pallavas are of Parthian origin. Mr. Vincent Smith defended this theory in the first edition of his *Early History of India*.¹ Mr. Lewis Rice² and Mr. Venkayya³ have adopted it. Mr. Swaminatha Aiyar has come to the same conclusion by another way.⁴ Mr. Fleet also favours this opinion.⁵
2. The Pallavas were descendants of Suvisaka, the Parthian Minister of the Mahākshatrapa Rudradāman. Such is the theory of Professor Jouveau-Dubreuil.⁶

1. Smith, *E. H. I.*, p. 348 (First Edition).

2. Rice, *Mysore and Coorg from the Inscriptions*, p. 53.

3. Venkayya, *The Pallavas*, A. S. I. Report, 1906-7, p. 221.

4. Cf. Gopalan, *History of the Pallavas of Kanchi*, pp. 23-24.

5. Fleet, *The Dynasties of the Kanarese Districts*, pp. 316-318 (Bombay, 1896).

6. Jouveau-Dubreuil, *Ancient History of the Deccan*, pp. 55-56.

3. The Pallavas are Tamilians, descendants of Ilantirayan—a Chōla-Nāga propuct—from the region known as Manipallavam (Jaffna, Ceylon). This is the opinion of Mr. Rasanayagam¹ and Mr. M. S. Ramaswami Aiyangar.²
4. The Pallavas are the milk-drawers of the Tamil country. So thinks Mr. Alexander Rea.³
5. The Pallavas are the same as the Kurumbas, the earliest inhabitants of the Tondamandalam. This opinion is quoted by Mr. Gopalan.⁴
6. The Pallavas were Nāgas, non-Dravidians, coming from the north of Tamilakam. Their present descendants are the Kallars or thieves of the Tamil country. This is Mr. M. Śrinivasa Aiyangar's theory⁵, accepted by Mr. Vincent Smith in his second edition of the *Oxford History of India*.⁶
7. The Pallavas were "a dynasty of the Andhras, probably related or even springing out of the clan of the Śatavāhanas". Such is the view of Dr. S. Krishnaswami Aiyangar⁷ whom Professor C. S. Srinivasachari follows.⁸
8. The Pallavas were "a mixed population, composed partly of foreigners and partly of South Indian tribes or castes differing in race from the Tamils, and taking their name from the title of an intruding foreign dynasty, which obtained control over them, and welded them into an aggressive political power." This is the modified opinion of Mr. Vincent Smith in the fourth edition of his *Early History of India*.⁹
9. The Pallavas are of Āryan origin and immigrants into South India. Such is the view of Mr. Gopalan.¹⁰
10. The Pallavas are a minor branch of the Vākāṭakas. This is the new theory of Mr. K. P. Jayaswal.¹¹

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1. Rasanayagam, *The Origin of the Pallavas*, I. A., LII, pp. 78-80.
 2. Ramaswami Aiyangar, *Studies in South Indian Jainism*, p. 143.
 3. Rea, *Pallava Architecture*, p. 2, note 5.
 4. Cf. Gopalan, *The Pallavas of Kāñchī*, p. 25.
 5. Śrinivasa Aiyangar, *Tamil Studies*, pp. 69-70, 214.
 6. Smith, *Oxford History of India*, p. 205 (Second Edition).
 7. Krishnaswami Aiyangar, *The Origin and Early History of the Pallavas of Kanchi*, J. I. H., II, pp. 24-25.
 8. Srinivasachari, *The Origin and Institutions of the Pallavas*, pp. 5-7.
 9. Smith, *E.H.I.*, p. 466 (4th Edition).
 10. Gopalan, *op. cit.*, p. 24.
 11. Jayaswal, *History of India*, pp. 180-183.

Of all these theories the soundest and best-founded, as it appeared to me once, was that which propounds in general that the Pallavas belong to the Āryan stock and were immigrants from Northern India. Indeed, the protection they rendered to Āryan culture, in spite of their domicile in Tamil land, would point to their racial affinities and the country of their origin. Hence the theory of Jayaswal, that they were but a branch of the imperial Vākātakas, once seemed to me quite probable and, in default of a better, even acceptable.

As regards the Parthian theory, my views were expressed in the following words when discussing the causes of the wars between the Chalukyas and the Pallavas: "It is not necessary to refute this opinion of Rice, which is now entirely obsolete and (which) has no other foundation than the remote similarity between the names of these two Dynasties and those foreign names."¹

Lately, however, while studying the history of Afghānistan, I came upon a number of facts related to the Parthian rule in Northern India, which made me change my views. I shall expound these facts in the following pages.

THE PARTHIANS IN SANSKRIT LITERATURE

It is well known that in ancient Sanskrit Literature the Parthians are called Parthavas or Parthivas or, more commonly, Pahlavas. Yet this similarity between the two words, Pahlavas and Pallavas, is of no value in historical research. The elements that count are facts, and these only will be considered here.

Much has been discussed about the origin of the Parthian race and, though at present the most common opinion connects them with the Turanian people of Central Asia, it is evident that the early Āryans of India believed them to be Āryans like themselves. In a number of Sanskrit works the Pahlavas are mentioned in connection with several other clans, amongst whom the Yavanas and Kāmbojas are always referred to as degenerate Āryans, though the cause of this degeneration is differently explained. Thus, in the *Mahābhārata*, they are said to have originated from the union of the four Hindu castes.² The *Vishṇu Purāṇa* attributes their lower status to the fact that they were divorced from the Vedic religious rites and abandoned by the Brāhmanas.³ Similarly, Manu informs us that all those races became degraded "through the loss of sacred

1. Heras, *Studies in Pallava History*, p. 28.

2. *Mahābhārata*, Shantiparva, Ch. 65, vv. 13-15.

3. *Vishṇu Purāṇa*, B. IV, Ch. II, (Wilson's Ed. p. 374-375).

ceremonies and by not seeing the Brāhmanas.”¹ Some of these ancient books openly aver that, though originally Kshatriyas², they had later become Mlechchas³ or Vṛśalas.⁴

All these phrases suggest a period when the Parthians and the other Āryan tribes formed one race and professed the same religion. Later, however, a division took place between the Parthians and kindred tribes on one side, and the bulk of the Indo-Āryan nation on the other. Still later, the Parthians and their companions once more meet the Indo-Āryans, are recognised by them as their ancient kinsmen, but are re-admitted into the Hindu fold not without reservations. These three stages of relationship between the Parthians and the Indo-Āryan nation undoubtedly point to the period of the Āryan invasion of India as a central factor. Before this invasion they all lived together on equal terms. But, subsequent to it, the religion of the Indo-Āryans evolved towards greater Brāhmanic influence, while the Parthians, remaining where they were or, perhaps, marching in an opposite direction, suffered a different religious evolution and lost contact with the Brāhmanic element. Hence, when they once more met on the plains of India, the Indo-Āryans despised their ancient kinsmen.

FIRST PARTHIAN INVASION

When did this second union take place? Two Parthian invasions must evidently be acknowledged by the historian. One, during an early period of literary tradition; the other, in a period of historical documentation. The *Harivaṁśa* refers to their exploits after the first invasion. In alliance with other invading tribes, Yavanas, Pāradas, Kāmbhojas and Śakas, they expelled Vahu from his kingdom of Ayodhyā, but were, years after, defeated by Vahu's son Sagara, who spared them at the urgent request of the high priest Vāsishṭha.⁵ That this invasion took place at a very early date, is proved by the fact that the Indo-Āryans still remembered that the Parthians had been their Kshatriya brethren before they themselves settled in India. Yet the date was not so early as not to allow a sufficiently long period for religious dissimilation. We cannot assign a precise date to this event, as the

1. *Ordinances of Manu*, X, 43-44.

2. *Viṣṇu Purāṇa*, loc. cit.; *Harivaṁśa*, Ch. XIV. v. 18; *Ordinances of Manu*, loc. cit.

3. *Viṣṇu Purāṇa*, loc. cit.; *Mahābhārata*, Bhismaparva, Ch. 9.

4. *Ordinances of Manu*, loc. cit.

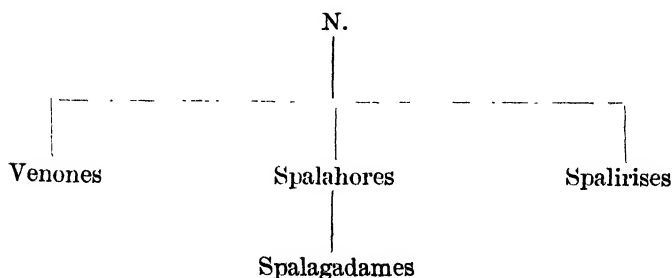
5. *Harivaṁśa*, Ch. XIV, vv. 3-4, 12-17.

chronology of that early period has not as yet been successfully traced. All we know is that Sagara is the 23rd predecessor of Daśaratha, the father of Rāma, on the throne of Ayodhyā.¹

It might be objected that these references to the Pahlavas in Sanskrit literature are only the effect of the invasion which is recorded in historical documents and took place shortly before these works were written or took their final shape. But this period, first century A. D., would be too late, for the Āryo-Indians remembered the Āryan origin of the Parthians. Moreover, the Pahlavas are always mentioned, in this early invasion together with the Yavanas and the Śakas. Now the Yavanas lived south of the Hindu Kush on the banks of the Kābul river as early as the 4th century B. C. They were found by Alexander the Great in the city of Mysa before he crossed the Indus.²

SECOND PARTHIAN INVASION

A new Parthian invasion took place towards the middle of the 2nd century B. C. The new Pahlavas first settled in the Kābul valley, but later migrated towards the Indus. The main historical documents we possess of these Parthians are their coins : and one or two inscriptions confirm the numismatic evidence. According to the latter, it seems that two Parthian dynasties ruled over the north-western provinces. The first Dynasty apparently had the capital of their kingdom west of the Khyber pass, perhaps in Kābul or Kandahar. Only four members and two generations of this family form this Dynasty, thus :



This Dynasty seems to have been overthrown by a Śaka dynasty.³

1. Cf. Pargiter, *Ancient Indian Historical Tradition*, p. 147.

2. Arryan, *Anabasis*, b. V., ch. I and II.

3. Whitehead, *Catalogue of Coins in the Punjab Museum*, Lahore, I, pp. 90-93.

The Second Dynasty seems to have had five members :—

Gondophares,
Abdagases,
Orthagnes,
Sanabares, and
Pakores,

But we do not know the order of their succession, nor their relationship among themselves, nor whether all of them were kings of the same territory, and not rather rulers of adjoining principalities. As a general rule, Gondophares is mentioned as the first king and founder of this second Dynasty.¹

There is no doubt that these, being practically the only owners of the valley of the Indus, were divided into several petty kingdoms; and we even know from the *Periplus* that they were fighting among themselves towards the middle of the 1st century.² In the village of Pahlādpur, in the Ghāzipur District, an inscription was found which mentions one Śiśupāla, "the Protector of the army of the Parthians."³ This Śiśupāla seems to have been another king of a petty Parthian kingdom.

Nor were the Parthians confined to the valley of the Indus. Coins of the later Parthian type with Chinese and Kharoshthi inscriptions have been found in Kotan.⁴ In Mathura there had been a family of Parthian Satraps who became famous through the inscriptions on the lion capital.⁵ Another Parthian Dynasty ruled over lower Sind and Cutch and extended their power as far south as Broach.⁶ Similarly, the Kshatrapa king Rudradāman in Saurāshtra had a Pahlava minister named Suviśākha, who was the Governor of two provinces.⁷ The Parthians, therefore, did not confine themselves to the north-eastern territories of Hindustan. Towards the close of the 1st century A. D., they had spread all over Northern India. An event took place by that time which favoured the spreading of the Parthians.

THE PARTHIANS GO SOUTHWARDS

From the first half of the first century the Kushāṇas had already settled south of the Hindu Kush range. Their first Indian

1. *Ibid.*, pp. 94-95.
2. Fleet, *Gupta Inscriptions*, pp. 250-251.
3. *J. A.*, VIII, p. 358.
4. Whitehead, *op. cit.*, p. 167.
5. Vogel, *La Sculpture de Mathura*, p. 19.
6. McCrindle, *Periplus*, p. 108, note 39.
7. *E. I.*, VIII, p. 49.

King, Kujala Kadhises, had fully succeeded the last Greek King of Kābul, Hermaios, after having reigned in friendship and alliance with him for some years.¹ His successor Vima Kadphises crossed the Khyber Pass and fell upon the fertile kingdom of Gandhāra. Whether its king was then Gondophares or some other of his dynasty, it is a fact that the Parthians had to retreat before the new invaders of the plains of the Hindustan. With the Parthians many Śakas also must have been pushed southwards, as it is well known that the members of these two nations, perhaps originally belonging to the same stock, were always found together.

It was on this occasion that the Parthians for the first time met another dynasty with whom they were to wage a long struggle. Those were the Andhras, the rulers of a great portion of Āryavarta and a much larger section of Dakṣiṇāpatha. Bhūmaka, the Parthian Satrap, wrested Saurāshṭra from the Andhras, though his son Nahapāna lost all those territories while fighting with the Andhra king Gautamīputra Śrī-Śātakarpi, "who destroyed the Śakas, Yavanas and Pahlavas,...who rooted out the Khakharāta (Kshaharātas, Bhūmaka's family) race; who restored the glory of the Śātavāhana (Andhra) family."²

STRUGGLE BETWEEN THE ANDHRAS AND THE KSHATRAPAS

A new adversary of the Andhras in Central India was the Satrap Chashtāna, the founder of the Kshatrapas, whose family was not so easily uprooted by the Andhras. The Kshatrapa Dynasty has always been called the 'Śaka'.³ Yet, if 'Śaka' is taken in its strictest sense of Scythian, the word does not seem to be fully satisfactory.⁴ Chashtāna seems to be a Sanskritized form of Tiastanes, the name that Ptolomy gives to this king.⁵ Now Tiastanes is purely a Parthian name. The Kshatrapa Dynasty is evidently a

1. See their joint coins, Morgan, *Manuel de Numismatique Orientale*, p. 363.
2. *E. I.*, VIII, p. 61.
3. Allahabad inscription of Samudra Gupta (Fleet, *C. I. I.*, III, p. 8); *Harṣa-carita* (Cowell and Thomas' Transl.), p. 194.
4. The word 'Saka' was often used for Scythians and Parthians indiscriminately. Even Rṣhabhladatta, the son-in-law of Nahapāna, whose family is always said to be Parthian, calls himself a Śaka. Cf. *E. I.*, VIII, p. 85. After all, since the Parthians were a Scythian tribe, they could justly call themselves Śakas. Moreover, before coming down to Kathiawar, the Parthians had lived with the Scythians in Śakastana (Seistan).
5. Ptolomy, VII, I, 63.

Parthian Dynasty. Their coins are all marked on the reverse, with the symbols of the sun and the moon (crescent) which are always found on the coins of the Parthian Arsacidan kings of Persia from the time of Mithridates III.¹ There is not a single Kshatrapa coin without those symbols. The fact that in some of their early coins a Greek inscription is engraved round the portrait of the king and that the Brāhmi inscription has some characters that resemble the Kharoshthi script,² clearly shows their connection with the north-western territories, where these two scripts only were used.

Chashṭana's grandson, Rudradāman I, seems to have extended his dominions, as he assumed the title of Mahākshatrapa and contracted a family alliance with Gautamīputra himself. Rudradāman's daughter was married to Vāsiṣṭhiputra Śrī Puṣumāvi, Gautamīputra's son.³ Yet this family connection did not prevent the war between the Śakas and the Pahlavas on the one side and the Andhras on the other. The Girnar inscription of Rudradāman refers to the war between these two nations. Rudradāman "twice in fair fight completely defeated Śātakarṇi, the lord of Dakshināpatha, but, on account of the nearness of their connection, did not destroy him."⁴ These reverses naturally reduced the kingdom of Puṣumāvi, while adding to the kingdom of Rudradāman. We do not know of more contests between the Andhra and the Kshatrapa armies; but, after the third successor of Puṣumāvi, the Andhras seem to have lost all the central and western territories of their dominions, as the coins of the last three kings are only found in the Godāvari District.⁵ At the same time, a branch of the family, some of whose members bear the title Viḷivāyakura,

1. Wroth, *Catalogue of the Coins of Parthia*, pl. XIII, No. 13 and ff. Generally all the authors speak of the crescent and the star, the latter being represented by a dot or a small circle surrounded by rays. But a star had no special significance, while for the Persians, even those prior to Zarthustra, the sun, together with the moon, was an object of special veneration. The late Sassanian monarchs placed the same symbols on their coins, from which they were adopted by the Arab conquerors and finally passed to Turkey. In the course of that migration the sun definitely became a star, as we see it on the Turkish flag.
2. Rapson, *Catalogue of Coins of the Andhra Dynasty*, p. 72.
3. Kanheri inscription, *I.A.*, XII. p. 273; Buhler, *A.S.W.I.*, V, p. 78, Pl. LI, 11.
4. *E. I.*, VIII, p. 47.
5. Rapson, *op. cit.*, p. xliii.

rule independently from Kolhāpur,¹ while some of their Cuṭṭu Viceroys strike coins and are called Mahārajas at Banavāsi.² This shows that the west had been cut off from the east. What was the power that had divided the Andhra southern possessions and practically confined the last Andhras to the Godāvāri and Kṛishṇa Districts ?

In order to answer this question we must return to the last important king of the Andhra Dynasty, Gautamīputra Yajña Śrī Śātakarṇi. This king guided the destinies of the Andhra nation for at least 27 years, for one of his inscriptions in the Kṛishṇa District, in the East, is dated the 27th year of his reign. Some of his earlier inscriptions are found at Nasik (7th year)³ and at Kanheri (16th year).⁴ But the most interesting piece of information about this ruler is derived from his coins. Some of these are not like any other Andhra coins. They belong to the Kshatrapa-Surāshṭra type, with the bust of the king on the obverse and the so-called *chaitya*, sun and moon, etc., on the reverse, with the usual inscriptions.⁵ The Guptas struck coins of the Surāshṭra type after conquering Surāshṭra. But ours cannot be a case of Andhra domination of the Kshatrapa kingdom ; for the Kshatrapas continued ruling in Malwā and Surāshṭra for nearly two centuries longer. Moreover, coins of some of the latter Kshatrapa kings are found as far south as Karad, south of Satara.⁶ The opposite seems to have been the case. The successors of Gautamīputra Yajña Śrī Śātakarṇi are only found in the Godāvāri District. His last inscription is also found in the Kṛishṇa District. This seems to point to a great defeat, and the coins tell us by whom this defeat was inflicted. The old enemies of the Andhra Dynasty, the Parthian rulers of Malwā and Surāshṭra, continued their aggression and conquered most of the Andhra territories. Gautamīputra Yajña Śrī Śātakarṇi had to take shelter in his eastern dominions and was perhaps forced to acknowledge the Kshatrapas as his overlords. This explains the imitation of the coins of the Kshatrapas whose subject he now was.

1. Smith, *E.H.I.*, p. 231.

2. *I. A.*, 1885, p. 331.

3. *E. I.*, VIII, p. 94.

4. Bühler, *A. S. IV. I. V.*, p. 79.

5. Rapson, *op. cit.*, pl. VII.

6. Newton, *On the Sak, Gupta and other ancient Dynasties of Kathiawar and Guzerat*, *J.B.B.R.A.S.*, VII, p. 16.

Now, accepting the chronology of Vincent Smith, which seems quite reasonable, the Andhras, acknowledgment of the Kshatrapas as their overlords must have occurred about the year 193 A. D., corresponding to the 27th year of Gautamīputra Yajña Śrī Śātakarṇi (Kṛishṇa inscription). His three successors are known to us only through the Purāṇic lists, and in the year 225 the Andhra Dynasty came to an end. We hear nothing about the state of the country and its rulers from this date as far as the year 325, when Kumāraviśṇu, otherwise called Śivaskandavarman, conquered the city of Kāñchi and made it the capital of the Pallava kingdom.¹ Are we really entitled to suppose that this Pallava ruler was a descendant of the old Pahlavas of Northern and Western India, who had been at war with the Andhras for a number of years? This is the crucial point of this paper.

The reasons that incline me to believe that they are the same, are several. I shall set them forth briefly :

1—THE ANCESTORS OF THE PALLAVAS.

In the Bahūr Plates of Nripatungavarman and in the genealogical section of the grant there are some names which are apparently the link between the Pallavas of Southern India and the Pahlavas of the North-Western Frontier. In this *vanīśāvali*, the first historical name seems to be Pallava. This name is already mentioned in the Kaśākudi² and in the Vēlūrpaḷayam Plates³; yet, in these inscriptions, no fact (or eulogy) of historical importance is given against that name. But in the Bahūr Plates, something is said of him of extraordinary historical importance. He is said to have “ruled the kings residing in the nine continents, together with the ploughmen”.⁴ The first part of this eulogy merely means that he exercised great power and authority in general, while the second specifies this authority as regards the members of a particular group in the social hierarchy, *viz.* the ploughmen. This seems to imply that, for some benefits conferred on the agriculturists, he enjoyed great influence amongst them. Now, who was this Pallava who fostered agriculture in such a way as to become so popular and respected among the tillers of the land?

During the reigns of Chandragupta Maurya and Aśoka a very large dam called Sudārsana was built near the Girnar mountain at Jūnāgadh, and brought great prosperity to the

1. Cf. Heras, *Studies in Pallava History*, pp. 9-16, 22.

2. *S. I. I.*, II, p. 355.

3. *Ibid.*, p. 510.

4. *E. I.*, XVIII, p. 13.

cultivators of that section of Saurāshṭra. But, unfortunately, this dam, was blown down by a great storm in the reign of Mahākshatrapa Rudradāman. The Governor of that province was then one Suviśāka, a Pahlava, who "for the benefit of the inhabitants of the towns and country, had been appointed by the King in this government to rule the whole of Ānarta and Surāshṭra; (a minister) who by his proper dealings and views in things temporal and spiritual increased the attachment (of the people); who was able, patient, not wavering, not arrogant, upright, not to be bribed, who by his good government increased the spiritual merit, fame and glory of his master." Now, the breach in the dam was very wide, and the counsellors and executive officers of Rudradāman "opposed the commencement" of the work. In the meantime, the people, foreseeing famine and poverty as the natural consequence of that calamity, "in their despair of having the dam rebuilt were loudly lamenting." Then Suviśāka, the Pahlava, in defiance of the king's counsellors, and apparently at his own cost repaired the dam¹, thus earning the gratitude and confidence of the farmers of Saurāshṭra. Hence his great authority among the ploughmen. He therefore seems to be the ancestor of the Pallava Kings of Kāñchi, called "Pallava" in some of their grants.

Now, one of the descendants of the Pahlava Suviśāka, according to the same Bahūr Plates, was a chief called Koṅkaṇika.² He stands in the genealogical tree between the said founder of the family, Suviśāka, and his descendants who were actual rulers of the Toṇḍamandala. It has been suggested that this Koṅkaṇika was introduced here from the genealogies of the Western Ganga Kings, whose ancestor is said to have been one Koṅkaṇi.³ But the Pallava family had nothing to gain from this spurious connection with the Western Gaṅgas. The fact that other Pallava grants do not mention Koṅkaṇika at all cannot be brought forward against his historicity. For, in all these inscriptions, even in those that supply the best information, as the Vēlūrpaḷayam and the Kaśākudi Plates, the list of Pallava ancestors is not complete.⁴ Indeed, Koṅkaṇika seems to mark another step in the long journey of the family from the North-Western Frontier down to Kāñchipuram. The name Koṅkaṇika points to a region out of which this Pallava

1. *Ibid.*

2. *E. I.*, XVIII, *loc. cit.*

3. Hultzsch, *Bahur Plates of Nripatungavarman*, *E. I.*, XVIII, p. 7.

4. *S. I. I.*, II, pp. 346, I, 45 ; p. 510, v. 9.

chief came finally towards the east. Koṅkaṇika means 'of the Koṅkaṇ'. Evidently this was not his real name, but, having come from the Koṅkaṇ, the people of the country where he went and amongst whom he finally settled, surnamed him Koṅkaṇika just as, later, the Telugus were called Vadukers (Northerners) in the Tamil country, and even to-day those who come from Kauśāmbi are called Kosāmbis and others Patankars or Biwandivallas.

This shows that the descendants of Suviśāka were for a time in the Koṅkaṇ, whence they finally crossed the whole breadth of the peninsula and settled in Andhradeśa, thus following the victorious course of the Kshatrapa armies against the Andhras.

2—THE PALLAVAS DEFEAT THE LAST ANDHRA KING

In the Vēlūrpaḷayam Plates of Nandivarman III, there are some details referring to the early members of the Pallava family which I could not explain in my previous attempts, but which can now be satisfactorily accounted for in relation to their origin. These details refer to the first two kings of the family. As I have proved elsewhere, these two kings were Virakūrchā and Skandaśishya.¹ Their historical predecessors Kālabhartṛi and Chūtapallava were very likely Parthian noblemen or generals, finally settled in the south in the wake of the army of the Parthian Kshatrapas of Malwā and Saurāshṭra. The inscription says of Virakūrchā that "simultaneously with the daughter of the chief of serpents, he grasped also the complete insignia of royalty".² In these words two facts are clear: (i) Virakūrchā's marriage with the daughter of the chief of serpents, *i. e.* a Nāga Princess; (ii) that he grasped the complete insignia of royalty, or, in other words, that he became a king. Now these two facts, according to the inscription, are simultaneous, and evidently so related to each other that one was the cause of the other: the marriage with the Nāga Princess was the cause of her husband becoming a king. This is not strange at all, for it is well known that the Nāgas were indigenous rulers of South India, and by marrying a Nāga Princess, Virakūrchā might perhaps have succeeded his father-in-law in course of time, if this king had no male issue, or might have received a portion of the Nāga kingdom as his wife's dowry.

1. Cf. Heras, *Studies in Pallava Genealogy*, p. 9.

2. *S. I. I.*, II, p. 510. This marriage is also referred to in the Rāyakōṭa Plates of Skandaśishya-Vikramavarman, *E. I.*, V, p. 51.

An inscription of the Andhra king Śrī Puṣumāvi seems to furnish some details about the territory acquired through this Nāga union. The inscription mentions "the country of Sātavahani-hāra belonging to the great general Kharīdanāka (for Skandanāga)."¹ The first step would be to inquire who was this Śrī Puṣumāvi in whose time this inscription was engraved. Dr. V. S. Sukthankar, who has edited the inscription, thinks that he must be Puṣumāvi II Vāsisthīputra, for the simple reason that the inscription records the building of a tank in the eighth year of the king, while "both Puṣumāvi III and Puṣumāvi IV reigned only seven years according to Mr. Vincent Smith."² But the latter's authority would hardly be great enough to decide a question of only one year's difference, specially when Dr. Sukthankar himself acknowledges that the alphabet of this inscription resembles that of the Jaggayyapeta inscription of Purisadata, which, according to Dr. Bühler, belongs to the 3rd century A.D.³ Now Puṣumāvi IV is precisely of the beginning of the 3rd century, as he ascended the throne in 218 A. D. This Puṣumāvi was the king twice defeated by Rudradāman and in whose time the period of Pallava influence in Andhradeśa commences.

The chief mentioned in the inscription as the immediate ruler of the country where the tank was built is called Skandanāga. This name is very suggestive, for just then there was a feudatory chief of the Andhra king whose name was Skanda or Skandaśishya and whose mother was a Nāga Princess. Mahāsēnāpati or the Great General Skandanāga, seems therefore to be identical with this chief who, following the custom of the Andhra kings⁴, includes in his own name the name of his mother. His territory is called Sātavahani-hāra, which seems to be the Sātāhani-raṭṭha of the Hirahāḍagalli plates of his son Śivaskandavarman.⁵ These very plates were purchased from a merchant of the village of Hirahāḍagalli in the Bellary District; and this inscription mentioning the Sātavahani-hāra is in the Ādōni Taluqa of the same District. It seems therefore that the country called the Sātavahana province which was ruled by the Mahāsēnāpati Skandanāga, roughly corresponds with the north-eastern portion of the Bellary District. This was therefore the territory acquired by Virakūrchā by his marriage with the Nāga princess.

1. *E. I.*, XIV, p. 155.

2. *Ibid.*, p. 154.

3. *Ibid.*, p. 153.

4. Vāsisthīputra, Gautamīputra, etc.

5. *S. I. I.*, II, p. 510.

Skandaśishya or Skandanāga ruled this territory during the short reigns of the last three Andhra rulers, and his power eventually increased, while that of his overlord was on the wane. And it was while he was ruling this province that he "seized from king Satyasēna the *ghaṭikā* of the twice-born." These words certainly point to a war. No king could ever take from another king a piece of land, much less a *ghaṭikā* of Brāhmanas, without war. This shows, then, that Skandaśishya, though only the second king of a feudatory dynasty, soon attempted to enlarge his territory at the expense of his neighbours, as was the custom in those days according to the principles of Indian polity.¹ Now, who was this king from whom Skandaśishya wrested this territory? Satyasēna has never been properly identified. Suggestions, nevertheless, have been made that from the ending of his name—'sēna'—one might see in him a member of the Kshatrpa family of Malwā and Surāshṭra, among whose kings several bear names with the same ending, such as Rudrasena, Vijayasena, Dāmasena and others.² But it is impossible to explain how Skandaśishya, whom we found in the south up to the time of his death, would go so far north to conquer territories from the king of Malwā and Surāshṭra. Moreover, it is a fact that, though in that Dynasty several kings possess names ending in -sēna, there is none called Satyasēna. So, in order to identify this king we must see what territory was wrested from him.

The Hirahadagalli Plates of Yuva-Mahārāja Śivaskandavarman inform us that this king renewed and confirmed the grant of a garden in Chillarekakoṭṭika to the Brāhmanas of the place who were mentioned in the document. Those Brāhmanas are called freeholders of Chillarekakoṭṭika, inhabitants of Āpiṭṭi. This seems to imply that Chillarekakoṭṭika was the name of the *agrahāra* or place where those Brāhmanas were living, while Āpiṭṭi was the village or town where this *agrahāra* was situated. This grant had already been made "by the great king, the lord Bappa." In my *Pallava Genealogy*, I identified Bappa with Kālabhartṛi,³ on the supposition that Kālabhartṛi was the founder of

1. Cf. Shamsastry, *Kautilya's Arthashastra*, p. 317 (Mysore, 1923).

2. Krishnaswami Aiyangar, *The Origin and Early History of the Pallavas of Kanchi*, J. I. H., II, pp. 39, 45.

3. Heras, *The Pallava Genealogy*, Chart I. I cannot agree with the interpretation of Dr. Buhler who differentiated the Brāhmanas of Āpiti from those of Chillarekakoṭṭika. The phrase found towards the close of the document "it must be exempted and caused to be exempted

the Pallava Dynasty.¹ Yet, after careful examination and consideration of all the possible issues, I am now of opinion that the identification of Professor Jouveau-Dubreuil² is the correct one. Bappa is Skandaśishya, who "seized the *ghatikū* of the twice-born from king Satyasēna." He is the same king that in the Rāyakōṭṭa plates is called "adhiraja Skandaśishya".³ Now Śivaskandavarman, after obtaining a great victory, which we have identified with the conquest of Kāñchi,⁴ renews and confirms a grant of a garden to the Brāhmanas of Chillarekakoḷuṅka; and while doing this he remembered the original grant made by his father. There seems to be some parallelism between these two events, the original grant and its confirmation. In point of fact, the unnamed "*ghatikū* of the twice-born of king Satyasēna" seems to be the *agrahūra* of Chillarekakoḷuṅka, to whom the father granted the garden on conquering the place, while the son confirmed the grant upon the conquest of Kāñchipura.

Where was this *agrahūra* of *ghatikū* of Chillarekakoḷuṅka? The inscription says that it was in the *rattha* or *district* of Sātahāni, *Sātahāni-rattha*.⁵ This word apparently stands for Sātahāni or Śātakarṇi, which evidently means a district that had lately been under the Śātakarṇi sway. In point of fact, all local indications of the early power of the Pallava race prior to the conquest of Kāñchipura point to the Krishṇa District, which was the last remnant of the great Andhra power. I would, therefore, suggest that the village of Āpiṭṭi is now represented by the modern village of Āppikaṭla in the Bāpaṭla Taluqa of the above District.⁶

by the inhabitants of Āpiṭṭi and by the inhabitants of Chillarekakoḷuṅka" is only an enumeration *a maiore ad minus* of the administrative units in connection with the Chillarekakoḷuṅka *agrahūra*, viz., Chillarekakoḷuṅka, that belongs to Āpiṭṭi, that belongs to the province. If this enumeration were to be taken literally, we should be forced to acknowledge a third group of grantees "in the province", of which there is no indication at all in the grant. We therefore do not consider Dr. Buhler was justified in inserting an 'and' between the "Brāhmanas of Chillarekakoḷuṅka" and the "inhabitants of Āpiṭṭi" at the beginning of the grant.

1. *Ibid.*, p. 21.
2. Jouveau-Dubreuil, *op. cit.*, p. 53.
3. *E. I.*, V. p. 52.
4. Heras, *Studies in Pallava History*, pp. 9-11.
5. *E. I.*, I, p. 6.
6. So writes the Collector of Guntur (18-8-35): "There are three *agrahūras* within a radius of about five miles from Bāpaṭla, of which one is depopulated".

Part of the temple of this village was built in A. D. 1172, according to a local inscription.¹ Six miles south-west of this village there is the town of Bāpaṭla, that seems to remind one of Bappa, the antiquity of which is proved by the archaeological remains found there. The local temple of Bhāva Nārāyaṇa Swāmi has five inscriptions of the Emperor Kulōttuṅga Choḍa-ḍeva, of the years 1136, 1142, 1143, 1145 and 1149.² These inscriptions show that the temple then was already a famous place of worship, and therefore rather ancient. Similarly, in the streets of the town there have been³ "carved stones with female figures, which Mr. Boswell considered to be of Scythic origin."⁴ Not far from this corner, very near the north-west boundary of the Bāpaṭla Taluqa, was found the Mayidavōlu grant of Śivaskandavarman.⁵ Near the mouth of the Kṛishṇa river another copperplate inscription was found of a king named Jayavarman, who on paleographical grounds also seems to be a contemporary of the early Pallava monarchs.⁶ All these facts seem to suggest that the centre of early Pallava rule in Andhradeśa was the south-west corner of the Kṛishṇa District, roughly corresponding to the Narsaraopet, Bāpaṭla and Repalle Taluqas.⁷

This clearly shows that the king called Satyasēna from whom Virakūrchā seized the *ghaṭikā* of the twice-born, was an Andhra King, most likely the last Andhra king, who was dispossessed of the throne by the Pallava monarch. Now, the last Andhra king, according to Vincent Smith, was Rāja Vāsishṭhīputra Swāmi Śrī Chandra-Śāta.⁸ His coins call him Vāsishṭhīputra

1. Mackenzie, *Manual of the Kistna District*, p. 205. (Madras, 1863).

2. *E. I.*, X, pp. 136-137.

3. Mackenzie, *op. et loc. cit.*

4. They are still at Bāpaṭla, according to a letter I received from the Collector of Guntur (18-8-35): "Regarding the carvings referred to in para 4 of your letter, they are still in Bapatla and they are not removed to any Museum. One of these is on the road leading to the sea. The other was enclosed in a temple."

5. *E. I.*, VI, p. 84.

6. *Ibid.*, p. 315.

7. It is not strange that this portion of territory south of the Kṛishṇa river is also called Sātahāni-raṭṭha as the original province ruled by Skandanāga-Skandaśishya. In later times—remember that the Hirahāḍagalli grant belongs to Skandaśishya's son, Śivaskandavarman, while being Yuvamahārāja—all the lands conquered from the Sātavāhana rulers were most probably denominated Sātahāni-raṭṭha.

8. Smith, *E. H. I.*, p. 232 (4th edition) Chart; *Z.D.M.G.*, 1902, p. 666.

Śrī Chandra-Śati.¹ It would not be strange therefore that he would be also styled Satyasēna.² The members of the new Pallava Dynasty would easily coin this name even if the king himself was not named thus, there being in the Parthian dynasty of Malwa and Surāshṭra so many kings with similar names.³

Just on the opposite bank of the Kṛishṇa river there was the southern capital of the Andhra kingdom, called Śrī Kākulam.⁴ Whether the capital was also conquered by Skandaśishya on this occasion is not said in the epigraph. This silence probably means that the Mahāsēnāpati was content with the capture of the *ghaṭikā* and the adjoining territories on the south bank of the river, allowing that the *finest* Andhra king would disappear by himself and by the onslaught of other northern feudatories, like the Ikṣvākus⁵, Ānandas,⁶ and other petty dynasties that grew during the period of Śātavāhana decay.

Therefore, when the inscription records the seizing "of the *ghaṭikā* of the twice-born from king Satyasēna", it refers to one of the last events of the history of the Andhra dynasty, to which the Pallavas succeeded in southern Andhradeśa.

3—THE PALLAVAS RACIAL ENEMIES OF ALL OTHER SOUTHERN DYNASTIES

There is a very remarkable fact in the history of the Pallavas of Kāñchi which may, perhaps, have an explanation in their foreign extraction. From the day they appeared in Kāñchi as a great power, the hostilities between them and the other great Dynasties of the south commence and in the course of centuries these hostilities continue till the Pallavas are heard of no more. Buddhavarman, Śivaskandavarman = Kumāravishṇu's son, is denominated "the submarine fire to the ocean-like army of

1. Rapson, *op. cit.*, p. 30.

2. He is also given slightly different names by the Purāṇas; Chaṇḍaśrī Śāntikārṇa (*Matsya*), Daṇḍaśrī Śātakarni (*Vāyu* and *Brahmaṇḍa*) etc. Cf. Rapson, *op. cit.*, p. lxvii.

3. It may be objected that at least the first syllable of these two names are not the same; for one is ञ् and the other is ण. This difference is not of great importance, for in the inscriptions we find several names written in two forms; for instance, Kādambas and Kadambas, Chalukyas and Chālukyas.

4. Mackenzie, *Manual of Kistna District*, pp. 5 and 214.

5. Sircar, *Successors of the Satavahanas in the Eastern Deccan* pp. 9-32.

6. *Ibid.*, pp. 42-53.

the Chōlas" ¹, and these wars, so early commenced, continue with the Chōlas, with the Pāṇḍyas, with the Kadambas and with the Chalukyas. We do not hear of any truce or armistice, of any peace treaty between these four great kingdoms and the kingdom of Kāñchi; rather, the epithets given by the Chalukya Emperor Vikramāditya II to the Pallava monarch are suggestive: the latter is the former's "natural enemy" and "family foe".² Moreover, it is a fact that the Pallavas are always attacked by these great Dynasties, excepting the case of the conquest of Kāñchi, which was most likely wrested from the Chōlas, the southern campaign of Nandivarman Pallavamalla to recover the dominions which the Chōlas had reconquered,³ some wars with the Gaṅgas, and probably others with the Kadambas.

We find only three kings friendly to the Pallavas; Maṇavarma, king of Ceylon, who required the help of Narasimhavarman Mahāmalla for recovering his kingdom;⁴ some Rāṣṭrakūta kings, who, together with some Pallava monarchs, installed some Gaṅga princes on the throne;⁴ and the Koṟumbāḷūr chief, Paradurgamardana, who fought with the same Narasimhavarman Mahāmalla against the Chalukyas.⁵ Moreover, the long period of Gaṅga subjection to the Pallavas, from the time of the early kings Śivavarman and Skandavarman, each of whom enthroned a Gaṅga monarch,⁶ seems to have brought about a family alliance between the two families.⁷

These continuous wars of the great southern Dynasties against the Pallavas seem to suggest a racial hatred against them. But in the conduct of the Chōlas towards the Pallavas after the extinction of the latter this racial feeling is more apparent. The Pallava Dynasty of Kāñchi disappeared from the stage of history towards the close of the 9th century when the Chōḷa King Āditya I defeated Aparājitavarman. About a century and a half after, king Kulōttunga Chōḷa I ordered the great temple of Kāñchipura,

1. *S. I. I.*, II, p. 510

2. Vakkaleri Grant, *I. A.*, VIII, p. 26.

3. Cf. Heras, *The Victory of Bhūti-Vikramakēsarī over the Pallavas*, *J. R. A. S.*, 1934, pp. 43-44.

4. *E. C.*, VI, Cm. 50; IV, Yd, 60; IX, NI, 60. These, however, were purely social and ceremonial meetings, for otherwise the Rāṣṭrakūtas led several expeditions against Kāñchi. Cf. Gopalan, *op. cit.*, pp. 126-127.

5. Cf. Heras, *The Victory of Bhūti-Vikramakēsarī*, *op. cit.*, p. 36.

6. *E. I.*, XIV, p. 335.

7. *S. I. I.*, IV, pp. 181 ff.

called Rājasimhēśvaram and built by Narasimhavarman II Rājasimha, to be closed and the temple land to be sold and the temple premises and surroundings to be given to a certain person named in the record. From this time up to the second half of the 14th century, *viz.* during three hundred years, the temple remained closed; and when, at the latter date, the Vijayanagara prince Kumāra Kampana was conquering the south, his general, Koppaṇaṅgaḷ, having conquered Kāñchipura and found the temple closed, could tolerate it no more: "It is opposed to the sacred law," he exclaims in the inscription itself; "the closing of the shrine of this lord shall cease; the worship and the divine service shall be carried on from the month of Āḍi forward" etc.¹ What could be the cause of the strange ban passed by the Chōḷa king? It would at first sight seem to be an act against *dharma*, as Koppaṇaṅgaḷ thought three centuries later. But really it was not so. A temple built by a foreign king was not a good house of worship. This seems to have been the feeling of Kulōttunga Chōḷa when he ordered the closing of the temple. The hatred for the Pallavas had outlived then.

4—THE TITLE 'DHAMMAMAHARAJADHIRAJA'

The Hirahaḍagalli plates of Śivaskandavarman give him a title which is very significant. He is called *dhammamahārājādhirāja*.² Mr. Jayaswal referring to this title, unprecedented in the South, says: "It was an importation from the North, it was a Hindu edition or rather a Hindu counter-title of the Kushan '*Daivaputra Shāhānushāhi*.' Instead of being a *Daivaputra*, the Pallava king places his claim on his adherence to the orthodox law and the orthodox civilization, which was quite in conformity with the law of Hindu constitution. He was substituting *Darma* for the divine *Daivaputra*."³ It is true that the Kushāṇa kings used the title mentioned above; yet the main part of this title *Shāhānushāhi*, is not originally Kushāṇa. The Kushāṇas were a Turkish tribe of Central Asia, who had no kings proper nor an organised administration when they crossed the Oxus on their way to India. It is true that in their inscriptions the great Kushāṇas call themselves *Shāhānushāhi* and in their coins they are styled *Basileus Basileon* or *Shao Nano Shao*. But these titles neither translate the full meaning of the title of Śivaskandavarman nor originated amongst them.

1. *S. I. I.*, I, p. 120.

2. *E. I.*, I, p. 7.

3. Jayaswal, *op. cit.*, p. 184.

This is a title that was brought into India by the Parthians. The first king to use the title 'king of kings' seems to have been Amosis I of Egypt, who styled himself "king of kings" in all countries.¹ From Egypt, the title travels to Babylon, where Nebukadrezar I called himself "chief of the kings," and to Assyria, where Tukulti Ninurta I is proud of being "the prince of all kings."² From Assyria, Darius I introduced the title into Iran, styling himself "Shāhyaziya Shāhyazyānām," king of kings. The first Parthian kings of Persia, successors of the Achemenians, call themselves "Basileus megas," great king, in their coins; but Mithridates II renews that proud title without removing the adjective, 'megas'; thus the title reads "Basileus Basileon megas," great king of kings.³ Mithridates III again adopted the same title.⁴ It was in this combined way that the title finally migrated into India, and appears on the coins of the Parthian kings of the North-western territories.⁵ The Parthian kings of these territories used the title on their coins in Greek and in Sanskrit. Thus we read the following Greek inscription on the coins of Vonones: "Basileos Basileon Megalon Ononou" (of the great king of kings Onones). The same title is used by Spalirises and Gondophares.⁶ In Sanskrit the title is expressed thus on the coins of Gondophares: "Maharaja rajatiraja tratara devavrada Gudupharasa."⁷ After them, the first king to use this title in Northern India seems to have been Samudra Gupta⁸, whose coins are imitations of the coins of the north-west of India. Now, the title that was assumed by the Pallava king Śivaskandavarman is the exact Prakrit translation of the Parthian title: *mahārājādhirāja*. This was an entirely new title in Southern India, and since this innovation might have hurt the feelings of the Pallava subjects, Śivaskandavarman, in order to show that, though originally a foreigner he was a real

1. von Wesendonk, *The Title 'King of Kings,' Oriental Studies*, p. 489.

2. *Ibid.*

3. Wroth, *op. cit.*, pp. 30 ff.

4. *Ibid.*, p. 64 ff.

5. The king's title in India generally was "adhiraja" or at most after the Kushāṇa invasion "mahārāja". Thus Skandaśishya, Śivaskandavarman's father is called 'adhirāja.' *E. I.*, V, p. 52. Gautamīputra Śatakarni, after defeating the Parthians of Surāshtra is called 'rājarāja'. *Ibid.* VIII, p. 60.

6. *Ibid.*, p. 146.

7. Cf. Whitehead, *Catalogue of Coins of the Punjab Museum*, I, pp. 142, 144. 146.

8. Fleet, *C.I.I.*, III, p. 8.

Indian even in his religion, he wisely prefixed a magic word to his title: *dharmamahārājādhirājā*. Certainly great king of kings, but great king of kings within the Hindu Law !

5—THE ACCOMMODATING CHARACTER OF THE PALLAVAS

It may be objected that the names "Pahlava" and "Pallava" are not the same, but totally different, nor may the 'h' of the Brāhmi script easily be changed or mistaken for 'l'. This is certainly true ; they are two different names, nor can a mistake be lightly postulated.¹ Yet, we believe that this change of Pallava from Pahlava was deliberately planned and carried out.

The Parthian invaders of India were extraordinary in the way they adapted themselves to their new conditions. They now marked their coins with both Greek and Sanskrit inscriptions, just like their predecessors the Indo-Greek kings, the Sanskrit inscription being, as before, in Khāroshthi characters. Thus the Sanskrit inscription of Gondophares reads as follows ; *maharajataraja trātara devavrata Gudupharasa*.² They also struck some square coins, which is a shape purely Indian. Indeed, they continued having Greek gods, like Zeus, Hercules, Pallas and Nike on the reverse of their coins ; but, once at least, the image of Śiva also appears on their coins.³

Similarly, the Parthian kings of Surāshtra and Malwā, though they kept the title of *Kshatrapa* or *Mahākshatrapa*, which is a Sanskritized Parthian title, yet also use the word '*rajno*', of the king, which is purely Indian ; and they adopted the Sanskrit language and the Brāhmi script for their inscriptions. Their very names, from the second king of the Dynasty, were Indian—Jayadāman, Rudradāman, Rudrasimha, Yasōdāman, Dāmasena, etc. They adopted the title of *swāmi* and decorated their coins with purely Indian symbols, such as the elephant, the humped bull and the so-called *chaitya*.

It is not, therefore, strange that, when a Parthian family settled in the south, they followed the same procedure. To begin with, as regards their religion, they seem to have had no

1. Dr. Krishnaswami Aiyangar, *op. cit.*, J. I. H. II, p. 25, says that "the words 'Pahlava' and 'Pallava' are philologically one."

2. Whitehead, *op. cit.*, p. 146.

3. *Ibid.*

fixed principle apart from a very broad eclecticism, with very rare individual exceptions.¹ At first, during their stay in the Andhradeśa, where the Buddhists predominated, they seem to have leaned towards the Buddhists *dharma*. Thus two of their kings bore the name of Buddha, Buddhavarman (in the British Museum, Chendallūr and Vēlūrpālayam Plates and in the Vayalūr Pillar inscription) and Buddhyañkura (in the British Museum Plates). Yet these two kings are called—the former Skandavarman, which is a Śaiva name (in the Ōmgōḍu A and the Uruvapalli Plates) and the latter Vīravarman, which is also a Śaiva name (in the Māṅgaḷūr, Ōmgōḍu A and B, Pīkira and Uruvapalli Plates), and Kumāravishṇu, which is partly Vaiṣṇava and partly Śaiva (in the Chendallūr Plates). After this early period, their names are indiscriminately Śaiva or Vaiṣṇava: Skandavarman, Viṣṇugōpa, Nandivarman, Siṃhavishṇu, Narasiṃhavarman, etc. As regards their religious expressions in the inscriptions, Kumāravishṇu II = Buddhyañkura is said to meditate “at the feet of Bhagavat” and called “the fervent Bhāgavata”.² Nandivarman I is styled “a devout worshipper of Bhagavat”.³ Siṃhavarman II is again said to meditate “at the feet of Bhagavat”,⁴ but he is also said to have performed a pilgrimage to the *stūpa* of Amarāvati, erected a statue of Buddha there, and heard these words from Buddha (who is called ‘the lord’): “Well, well, lay worshipper, Siṃhavarman.”⁵ Mahēndravarman I, who seems to have been a Jaina in his youth, builds cave-temples to Varāhavatāra at Mahābalipuram,⁶ to Viṣṇu at Mahēndrapuram,⁷ to Śiva at Trichinopoly⁸ and at Dalavanur,⁹ and to Brahmā, Viṣṇu and Śiva together at Mandagapattu;¹⁰ and writes the *Matuvilasa-prahāsa*, in which he makes fun of the Buddhist monks. Narasiṃhavarman II Rājasimha builds the Rājasimheśvara temple to Śiva at Kāñchi, and is said “to bear Bhāva (Śiva) in his mind

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1. Mr. Jayaswal, in order to prove that they were a branch of the Vākātakas, says that they were Śaivas.
 2. Chendallūr Plates, *E. I.*, VIII, p. 236.
 3. Udayēndiram Plates, *E. I.*, III, p. 146.
 4. Pīkira Grant, *E. I.*, VIII, p. 162.
 5. Amaravati inscription, *S. I. I.*, I, p. 28.
 6. Cf. Heras, *Studies in Pallava History*, pp. 71-75.
 7. *E. I.*, IV, p. 153.
 8. *S. I. I.*, I, p. 29.
 9. *E. I.*, XII, p. 225.
 10. *E. I.*, XVII, p. 17.

which is humble with devotion".¹ Nandivarman Pallavamalla invokes Śiva in the Udayēndiram² and in the Vēlūrpalāyam Plates³; but in the Kaśākudi Plates his prayers are addressed to Brahmā, Viṣṇu, Śiva and other deities⁴; while his special devotion to Viṣṇu is seen from the statement that "the spotless race of the Pallavas resemble a partial incarnation of Viṣṇu."⁵ Vijaya-Nandivarman confesses that his head "never knew of bowing down to others excepting to the pair of the worshipful feet of Mukunda (Viṣṇu)".⁶

In all other spheres of life also did the Pallavas accommodate themselves to the country where they settled. Thus, the first charters they issued were in Prākṛit, for the Andhra kings whom they succeeded in Andhradeśa had Prākṛit as their Court language;⁷ but on conquering Kāñchi, they realized that this city was a centre of Sanskrit learning,⁸ and Budhavarman, the conqueror's son, commenced issuing the official charters in Sanskrit,⁹ a custom which was kept up to the end of the Dynasty.

Even the old Parthian title '*mahārājādhirāja*' once adopted by Śivaskandavarman = Kumāravishṇu after the conquest of Kāñchi, was not used by his successors as they found it too exotic in southern India, while they generally kept the word *dharma*. All the Pallava kings, his successors, call themselves '*Dharma Mahārāja*'¹⁰, with the exception of Nandivarman Pallavamalla, who styles himself '*Rājādhirāja Paramēśvara*'.¹¹ The same kings, when they write in Tamil, take up the half-Tamil title of "Kō-vijaya".¹²

In a word, these Parthians of the south, following the conduct

1. *E. I.*, X, p. 13.
2. *S. I. I.*, II, p. 370.
3. *Ibid.*, p. 510.
4. *Ibid.*, p. 353.
5. *Ibid.*, p. 355.
6. Taṇḍantōṭṭan Plates, *Ibid.*, p. 530.
7. *E. I.*, I, p. 5.
8. A very few years after, Mayūraśarman, the future Kadamba king, with his preceptor Viraśarman went to Kāñchi, "eager to study the whole sacred lore". Taḷagunda inscription of Kākusthavarman, *E. I.*, VIII, p. 34. Cf. Heras, *Mayūrasarman, the Founder of the Kadamba Dynasty and the Pallavas of Kāñchi*, *Proceedings of the 7th Oriental Conference at Baroda* pp. 539-547; Sircar, *The Early Pallavas*, *J. I. H.*, XIV., pp. 149-157.
9. Cf. Heras, *Studies in Pallava History*, p. 16.
10. Kumāravishṇu, II, *E. I.*, VIII, p. 235; Nandivarman I, *Ibid.*, VIII, p. 162; XV, p. 255.
11. *S. I. I.*, II, p. 358.
12. *E. I.*, V, p. 51; *S. I. I.*, II, p. 312.

of the Parthians of the north, embraced the Brahmanic religion in its widest possible sense and even performed Vēdic sacrifices;¹ and in their wish to naturalize themselves completely, by the slight change of a letter they converted their national name *Pahlava* into a purely Sanskrit name *Pallava*, a branch, certainly foreign in origin, but newly grafted on the trunk of the Hindu *dharma*.²

6—THE CASTE OF THE PALLAVAS

Moved by the same genius for adaptation, the Pallavas of Andhradeśa pretended to belong to the highest caste, the Brahman. Thus the Mayidavōlu Plates say that Yuva-mahārāja Śivaskandavarman "belongs to the *gōtra* of the Bhāradvājas."³ He is again called "a Bhāraddāya" in the Hīrahaḍagalli Plates⁴, and in the British Museum Plates of Chārudēvi⁵; several other inscriptions repeat the same Brāhmana pedigree: while the later inscriptions of the Dynasty, instead of saying that the Pallavas belong to the Bhāradvāja *gōtra*, introduce a portion of Purāṇic genealogy with Bhāradvāja in it, as their own mythical genealogy.⁶ Mr. Jayaswal takes this pretension as a proof that the Pallavas were really Brāhmanas, and belonging to the Vākāṭaka family.⁷

Yet, the fact that Bhāradvāja and his immediate relations are placed in the mythical portion of the pedigree, and even before Pallava and Aśokavarman, makes one suspect that this Brāhmana lineage was a relatively very late pretension of the family. And this suspicion becomes a certainty on the examination of the Tālagunda inscription of Kākusthavarman. Mayūrasarman, the young Brāhmana, the future founder of the Kadamba Dynasty, went to Kāñchi to study Sanskrit literature accompanied by his *gūru* Virāśarman. There he had once "a fierce quarrel with a Pallava horseman". Apparently, the fight ended unfavourably

1. *E. I.*, I, p. 7.

2. After all, this change was made in a very simple way. The Mayidavōlu Plates of the Yuva-mahārāja Śivaskandavarman—the first Pallava inscription known to us hitherto—seem to mark the transition. In this inscription the word *Pahlava* is written without the 'h' as *Palava*. In the following inscription the word is written with 'll'—*Pollava*. Cf. Jouveau-Dubretil, *Ancient History of the Deccan*, p. 55.

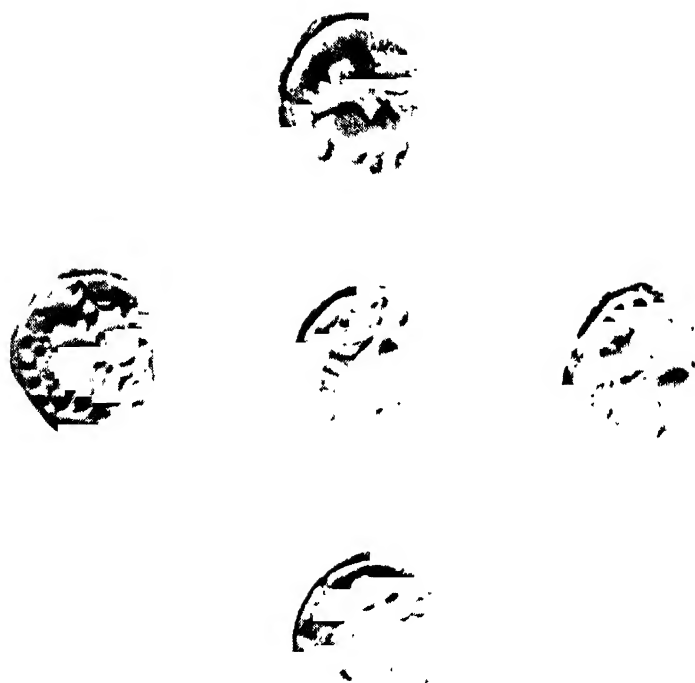
3. *E. I.*, VI, p. 88.

4. *Ibid.*, I, p. 7.

5. *E. I.*, VIII, p. 145.

6. Kaśākudi Plates, *S. I. I.*, II, p. 355; Udayēndiram Plates, *Ibid.*, p. 370; Velūrpālayam Plates, *Ibid.*, p. 510.

7. Jayaswal, *op. cit.*, pp. 181-182.



Pallava Coins showing a standing bull and the Sun and the Moon on top

(I. H. R. I., St. X. C.)

for Mayūraśarman, for the inscription says that, after the fight, the young Brāhmana exclaimed : "Alas, that in this Kali-age, the Brāhmanas should be so much feebler than the Kshatriyas." ¹ It is, therefore, evident that for Mayūraśarman the Pallavas were Kshatriyas ; he did not acknowledge them as Brāhmanas. ² We must admit that the testimony of Mayūraśarman on this point cannot be rejected. He was a Brāhmana himself and, though young, had studied Sanskrit literature for some time at Kāñchi itself and had with him his *gūru* Virāśarman. At least the latter would know that, traditionally, the Pallavas were Kshatriyas, but on no account Brāhmanas. That was a pretension that a true Brāhmana could never accept. ³

7—THE PALLAVA COINS

The Pallava coins also show the Parthian affinities of the Pallavas with the Kshatrapas. We have seen how the rulers of this Dynasty had kept the symbols of the crescent and the sun (depicted as a star), taken from the Parthian coinage of Persia, on the reverse of their coins. The Pallava kings, followers of the traditions of their race, also had these two symbols on their coins. During my last visit to Mahābalipuram, one of the *coolies* at the disposal of the visitors offered me a handful of coins. Some of them were evidently Pallava coins. I purchased the whole lot for a few annas. (Some of them are reproduced here.) On the reverse there is a bull standing to its *proper* right in six coins, and to its *proper* left in three of them. The neck of the bull is unnaturally twisted so that the whole head with the two horns might be properly seen. This image is enclosed within a circle of dots. Between it and the back of the bull, very near its hind quarters, there are the symbols of the sun and the moon, the former shown without rays in the ordinary Indian fashion, *viz.*, a full circle. The position of these two symbols is not always the same. Sometimes the sun is to the right and sometimes to the left. On the reverse, the inscription in the *grantha* of the period is written round the coins in the ordinary Kshatrapa fashion. Elliot also has published a Pallava coin that bears a bull with the sun and the moon. ⁴

1. *E. I.*, VIII, p. 34.

2. This event took place shortly after the conquest of Kāñchi by Śivaśkandavarman = Kumāravishṇu, and therefore when this king had already proclaimed himself a Bhāradvāja in the Mayidavolu Plates. Cf. Heras, *Mayūraśarman, the Founder of the Kadamba Dynasty, and the Pallavas of Kāñchi*, *loc. cit.*

3. *E. I.* VIII, p. 34.

4. Elliot, *Coins of South India*, pl. I. No. 35.

8—THE PALLAVA 'LĀNCHANA'

The same affinity is revealed by the Pallava *lānchana*, or heraldic device of the Dynasty. The Kshatrapas of Malwā and Saurāshṭra adopted a bull as their *lānchana*. On the coins of the Kshatrapas generally we have the profile portrait of the king surrounded by an inscription, on many occasions visible. Yet there are some coins of Jayadāman,¹ Jivadāman,² Rudrasinha I³, and Swāmi Rudrasena III⁴, on which there is a humped bull standing to its proper left; while a few nameless coins bear the same humped bull facing right⁵.

As regards the seals of their copper-plate grants, we cannot say anything definite, for no grants of these kings have been discovered hitherto. Yet, the fact that the Vallabhi kings of Saurāshṭra, who succeeded the Kshatrapas in that part of the country, struck their coins after the Kshatrapa fashion makes me suspect that their seals were also imitated from the Kshatrapa seals. Now the Vallabhi seals always show a humped bull, couchant. This clearly shows that the *lānchana*, though always the same, varied in its pose. European heraldry did not allow such changes.

What is the *lānchana* of the Pallavas? The Kaśākudi Plates of Nandivarman Pallavamalla explicitly tell us of one of the members of the family that his "crest is the bull".⁶ Accordingly, a bull, standing whether to the right or to the left, is represented on their early coins. As to their seals, the early Pallava plates have the bull standing to the left.⁷ From the time of Śivaskandavarman = Kumāravishṇu, the bull on the seals is always couchant.⁸

1. Rapson, *op. cit.*, Pl. X, Nos. 265-69

2. *Ibid.*, Pl. XI, Nos. 293-94.

3. *Ibid.*, Pl. XI, No. 234.

4. *Ibid.*, Pl. XVII, Nos. 889, 890.

5. *Ibid.*, Pl. XII, Nos. 326, 327.

6. *S. I. I.*, II, p. 354, v. 9.

7. *E. I.*, VIII, p. 142; *I. A.*, IX, Pl. op. p. 100 (Fleet, on p. 101 says that this seal "has, sunk in the surface of the seal itself, a standing animal, which looks more like a deer than anything else." Yet, after seeing the bull on the Pallava coins, and on the seal of Chārudēvi's plate, one has no doubt that this is also a bull). *I. A.*, V, p. 50 (The same may be said of this seal, about which Fleet, *loc. cit.*, says: "The seal connecting the plates bears the representation of what seems to be a dog, but is, in the native opinion, a lion.").

8. *E. I.*, IV, p. 180; VI, pp. 84-88; XVIII, p. 5; *S. I. I.*, II, pp. 345, 507.



Pallava Seal of the British Museum Plates of Charudevi



Pallava Seal of the Vēlūrpalayam Plates of Nandivarman

(Magnified two diametres)

9—THE ARTISTIC INFLUENCES OF ANDHRA-DESA

Huien-Tsiang visited the kingdom of the Pallavas towards the middle of the 7th century, during the reign of Narasimhavarman Mahāmalla. Unfortunately, he says nothing about this king or about his dynasty. Yet the information he gathered when passing through Andhradeśa is of extraordinary interest. His biographer, Hwui-Li, after mentioning the two monasteries of Dhanakātaka (for Dharanikōta, modern Amarāvati), Purvasita and Avarsita, already mentioned by the same Huien-Tsiang in the account of his travels, adds: "A former king of this country founded these for Buddha's sake; he thoroughly investigated the rules and patterns of Tahia (for constructing such buildings)".¹

What was the country called Tahia by the Chinese biographer? It has sometimes been translated as Bactria, but it seems more accurate to understand by it all that country towards the northwest of Hindustan which was conquered at the first instance by the Kushāṇas, *viz.* that part of modern Afghānistān, south of the Hindu Kush and the ancient kingdom of Gandhāra, roughly embracing the present North-Western Frontier Province and North Panjab, once inhabited by the ancient tribe of the Takhias or Takhas.² Huien-Tsiang had visited that country and admired the size and art of the Buddhist structures. Those of Nagarahāra (Jalalabad) were specially built during the Greek and Parthian period.³ The monasteries of Hiddo (Haḍḍa), and Purushapura (Peshāwar), arose through the magnificence of the Imperial Kushāṇas.⁴ The city of Taxila was also Parthian and Kushāṇa.⁵

Now, Huien-Tsiang, speaking of the Buddhist structures of Amarāvati, not only compared them with the buildings of Tahia, but explicitly told his disciples in China, at the end of his long journey, that for building them 'a former king of the country had thoroughly investigated the rules and patterns of Tahia.' A very striking piece of news, indeed, which he undoubtedly learned from the people of the country.

That this information was correct and not a fiction of the monks whom Huien-Tsiang visited or of Huien-Tsiang himself, the monuments themselves, though now in a fragmentary and dilapidated condition, magnificently prove. Let us examine them.

1. Hwui-Li, *Life of Huien-Tsiang*, p. 136.
2. *Mahabharata*, Adiparva, Paushya, *passim*.
3. Wilson, *Arriana Antiqua*, pp. 99 ff.
4. Beal, *Records of the Western World I*, pp. 97-100.
5. Cf. Marshall, *A Guide to Taxila*, pp. 13-17.

The most interesting of the Amarāvati sculptures are the figures of Buddha. They may be divided into two groups, according to their costumes. Some are represented with the *saṅghāṭi* covering the whole body, from the shoulders down to the feet. Others are dressed in the same *saṅghāṭi* worn in the *yajñōpavīta* fashion, leaving the right shoulder bare. The first fashion is precisely the style of the images of Buddha of the so-called Gandhāra school.¹ The Buddhas of Amarāvati in this attire are not many.² Yet, even the statues with one shoulder bare show the Gandhāra influence in their drapery folds.³ About them Smith says: "The opaque drapery is treated in a formalized style, quite different from the smooth transparent robes of the Gupta period...but to a certain extent resembling Gandhāra work".⁴

Among the motifs of ornamentation that remind one of Gandhāra art, the most noticeable is the garland motif. This is extremely common in the whole region south of the Hindu Kush. The Kābul Museum has the stone base of a *stūpa* adorned with a frieze in which nude *amorini* support a garland on their shoulders. This specimen was discovered at Haḍḍa (Jalalabad plains). The Peshāwar Museum is very rich in specimens of such garland frieze. These specimens are various. Sometimes there are no *amorini* but similarly nude *atlantes*, while in one case these *atlantes* have been carefully dressed. In many instances, over the lower wave of the garland, a new figure has been introduced in different dresses and poses.⁵ Smith gives three specimens of garland frieze, two from the Yusufzai country, probably some of those now exhibited at Peshāwar, and one from Mathura.⁶

The garland friezes of Amarāvati are evidently copied from this last type. Sometimes, the garland is supported by little *ganas* or seminude dwarfs, the upper portion of the garland wave being filled up by half an ornamental lotus flower.⁷ Sometimes, instead

1. Cf. Foucher, *Early Indian Sculpture*, I, p. 110;

2. Bachchoffer, *op. cit.*, fig. 131; Coomaraswamy, *History of Indian and Indonesian Art*, Pl. XXXIII, Nos. 137, 141.

3. Cf. Bachchoffer, *op. cit.*, p. 111; Coomaraswami, *op. cit.*, Pl. XXXIII, Nos. 138, 139.

4. Smith, *History of Fine Art in India*, pp. 153-54.

5. Cf. Hargreaves, *Handbook to the Sculptures in the Peshawar Museum*, Pl. 2, (b).

6. Smith, *op. cit.*, p. 383.

7. Bachchoffer, *op. cit.*, II, fig. 112.



A Garland Frieze of the Amarāvati Stupa

(*Madras Government Museum*)



A Fragment of a Frieze of the Amarāvati Stupa, showing Buddha mounted on a horse
at the time of his renunciation

(*Madras Government Museum*)



A Fragment of a Beam of the Amarāvati Stupa showing a horse
in the lower left corner

(*Madras Government Museum*)

of *ganās* or *amorini*, grown-up men support the garland, the upper portion of the wave being filled up by Buddhist symbols, a *stūpa*, a *chakra*-pillar, a *bodhisattva*, etc.¹ In one specimen, instead of one man supporting the garland, this seems to be hanging on the ceiling, while below there is a man and a woman, a man with a monkey, etc.² Smith, commenting upon one of these garland friezes says: "Fig. 103 gives a characteristic specimen of the Amarāvati treatment of the wavy garland or roll motif. The Hellenistic nude Erotes have developed into full-grown Indian men in waist clothes and the imbricated Roman roll of Gandhāra is replaced by a much thicker roll of tinsel covered with elaborate patterns."³ The same specimen is spoken of by Coomaraswamy: "A long wavy floral scroll, carried by men who are really Indianized analogues of the garland-bearing Erotes of Gandhāra, which found their way into India *via* Mathura."⁴

Another feature that betrays the so-called Gandhāra influence in the Amarāvati sculptures is the representation of horses. The horses of Amarāvati are totally different from the horses of Sañchi, for instance. They are more similar to the horses of the Greco-Indian coins, the horses on the coins of Eukratides⁵, Heliokles⁶, Antimachos⁷, Polixenos⁸, Nikias⁹, and Hippostratos¹⁰. The horses of Amarāvati are full of vitality, with rounded muscles, ready, as it were, to trot out of the panel and start for a race.¹¹ The horses of Sañchi, perhaps carved a century before, though they are in front of a chariot, with one of the front legs raised from the

1. *Ibid.*, fig. 123, 124; Smith, *op. cit.*, p. 152, fig. 103.

2. *Ibid.*, fig. 124.

3. Smith, *op. cit.*, p. 153.

4. Coomaraswamy, *op. cit.*, p. 70. From the eastern coast, the garland motif travelled to the old Chalukya kingdom. We find it decorating the beam in the Papanātha temple at Pattadakal. Nude *ganās* support the garland, the upper portion of the waves being filled up by a scroll. Cf. Cousens, *The Chalukyan Architecture*, Pl. LIII. I have explained the origin of the Pallava influence in the Pattadakal temples elsewhere. Cf. Heras, *Studies in Pallava History*, pp. 59-60.

5. Whitehead, *op. cit.*, Pl. II. No. 64.

6. *Ibid.*, Pl. III, No. 142.

7. *Ibid.*, Pl. VII, No. 557.

8. *Ibid.*, No. 576.

9. *Ibid.*, No. 602.

10. *Ibid.*, Pl. VIII. Nos. 610, 614-617.

11. Cf. Bachchoffer, *op. cit.*, figs. 120, 126, 128; Smith, *op. cit.*, p. 153, No. 104.

ground, cannot walk at all ; as the two accompanying illustrations will show, those of Amarāvati are living animals.

Now to pass from individual figures and motifs to some of the technical features, the first thing one notices is that the classical canons of Indian iconography regarding the size of the statues of the wife, or in general of women, are not followed in Amarāvati. Such canons prescribed that the wife should be represented much smaller than the husband : thus, in the *stūpa* of Jaggayyapeta, not very far from Amarāvati, the wife is represented almost half the size of her husband. (See illustration). This *stūpa* was erected in the second century B. C., that is much earlier than the upper casing of the Amarāvati *stūpa*. The artist of Amarāvati ignored this canon absolutely. The wife is represented of the same size as the husband, and, in general, all persons are of the same size, irrespective of sex. (The reproduction of an Amarāvati panel will show the contrast between this and the Jaggayyapeta carving).

Another technical feature is the perspective in the carvings. The carvings of Amarāvati are not flat, like those of Sañchi. They have corners and recesses and different planes and space. This is a very important point, for such achievement was unprecedented in India, except in its North-Western corner.

The Gandhāra influence in the several details we have pointed out, is also noticed elsewhere in Andhradeśa. In the recently discovered *stūpa* of Goli, in the Guntūr District, such influence is also clearly discovered. Mr. T. N. Ramachandran, of the Madras Museum, who has described the Goli carvings, has pointed out that the costume of two, out of the five, figures of the Buddha is purely of the Gandhāra type.¹

Finally, Professor Jouveau-Dubreuil has discovered Greco-Roman influence in many statues of the early Pallava period found in Andhradeśa. "The subjects", says he, "are Buddhistic, the costumes and ornaments are Hindu, but their workmanship is European. But, above all, it is in the representation of the human body that the European influence manifests itself. The hair is curled in the Greek manner, the face is symmetrical, the limbs are sculptured according to the rules of anatomy with conspicuous muscles, and some of them are dressed in clothes that remind us of the Roman toga."² And later on he adds : "In many places on the banks of the Krishṇa, we find sculptured marbles of

1. Ramachandran, *Buddhist Sculptures from a Stupa near Goli village*, p. 23.

2. Jouveau-Dubreuil, *The Pallavas*, p. 110 (Pondichery, 1917).



A Fragment of the Pannelling of the Jaggayyapeta Stupa showing the figures of two women much shorter than the figure of a man

Madras Government Museum



**A Fragment of a Post of the Amarāvati Stūpa showing
men and women of the same size**

(Musée Guimet, Paris)

which the subjects are Buddhistic and the workmanship Roman. These are the bas-reliefs that once adorned the *stūpas* or the mutilated images of Buddha. Up to the present they have always been attributed to the Andhras. This view, I am sure, is not always correct.

"The Graeco-Buddhist art did not certainly disappear with the Andhra dynasty. It is not likely that the technical methods employed by the sculptors who built the *stūpa* at Amarāvati, disappeared completely in the space of a few years. It is almost certain that this art that flourished in the middle of the II century lived for more than one century and that it was only very slowly that the sculptors abandoned the ancient models that they had been taught by the artists that had come from Rome. To be more precise, I believe that the Indo Roman art attained its zenith in the II century with the *stūpa* of Amarāvati : that throughout the III century, the art used on the banks of the Krishṇa was entirely Indo-Roman ; that in the IV century there was still very evident traces of this influence and it was only in the V century that all vestige of Latin influence disappeared completely.

"Indeed, many of the marbles that have been discovered on the banks of the Krishṇa do not date from the time of the Andhras, but have been sculptured when the Pallava kings reigned over this country.

"On the 1st January 1917, I went to Bezvada with the object of visiting the caves of Undavalli. When going about these regions, I luckily discovered the ruins of a Buddhist temple at Vijiaderpuram, a village half a mile to the west of Bezvada. Amongst the remains of the brick walls, there were two heads of Buddha and a trunk dressed in the Roman toga. One of these heads was very beautiful. I bought it from the owner, a temple priest, for two rupees and have it now in my possession." ¹

Even outside Andhradeśa some specimens of this art discovered at Amaravati have been found. Mr. T. A. Gopinath Rao found a standing image of Buddha, similar to those of Amarāvati and Gandhāra in the innermost *prākāra* of the Kāmākshidēvi Temple at Conjeevaram, the old Kāñchi of the Pallava monarchs.²

Several explanations have been advanced to account for this so-called Greek or Roman influence over the sculptures of the early Pallava period, in Andhradeśa and elsewhere. Dr. Coomaraswamy

1. *Ibid*, pp. 10-11.

2. Gopinath Rao, *Buddha Vestiges in Kanchipura*, I. A., XLIV, p. 128, fig. 1.

supposes that the North-Western artistic influence was felt in Andhradeśa *via* Mathura.¹ The same view is held by Bachchoffer. After describing the little transformation of the Gandhāra Buddha operated at Mathura, according to Indian ideals, he adds : " In this shape the Buddha coming from his home in Mathura conquered the South. " ² Yet this migration of the statue of Buddha from Mathura down to Amarāvati, and for the matter of that, any political or intellectual relations (intercourse) between Mathura and Andhradeśa that would explain the northern artistic influence in Southern India, are facts supposed, but never proved, independently of this problem.

On the other hand, Professor Jouveau-Dubreuil thinks that the influence did not come from the north, but from beyond the ocean. " At this epoch, the Roman Empire extended its influence over almost the whole of the civilized world and was also connected with India in various ways... There is no doubt that in its origin the Pallava art was strongly influenced by the principles of Latin art. " ³ The possibility of Roman influence is ably discussed by Bachchoffer. Indeed, the numerous Roman coins discovered at different times all over Southern India satisfactorily establish the relations between that great Empire and the South. Yet, as he wisely points out, " it is very questionable whether the Roman art of the Imperial period had come over to Southern India with the merchants. The art under Trajan (A. D. 98-117), of which one may be tempted to think, exhibits such a fundamentally different character that the possibility of its influence upon Amarāvati cannot be seriously taken into consideration. It is rather the Marcus column which reminds us of India, but more of the art of Sāñchi than that of Amarāvati. Now the Marcus column was completed in A. D. 193 and the similar manner of perception met with at Sāñchi, preceded the Roman art by fully two centuries.

" The fact alone that all that appears at Amarāvati had already had its prototype at Sāñchi refutes the theory of a Roman influence. It would perhaps be more correct to say that Roman and Indian plastic art had independently reached the same point of perceptual representation, with the significant difference, however, that what in Rome meant a retrogressive movement represents at Amarāvati the end of a long development. " ⁴

1. Coomaraswamy, *op. cit.*, p. 70.

2. Bachchoffer, *op. cit.*, I, p. 110.

3. Jouveau-Dubreuil, *op. cit.*, p. 10.

4. Bachchoffer, *op. cit.*, pp. 121-122.

Finally, Smith, conscious that the influence of Mathura cannot be historically explained, tries to find out the Greek influence through a different way: "Historically," says he, "the sculptures (of Amarāvati) are interesting as an academic development of the style of Sāñchi and Bārhut, with a stronger tinge of Hellenistic influence, perhaps coming by sea from Alexandria and through the ports rather than from Gandhāra. Considering the geographical and political separation of the Kushān and Andhra Empires, I think the presumption is that the sculptors of Amrāvati had not direct knowledge of the Gandhāra School although it is possible that they may have had it."¹

Again the commercial intercourse between Greece and the eastern coast of South India through Alexandria or other harbours, is another totally unwarranted supposition. Yet Smith does not deny the possibility of some sort of relationship between Gandhāra and Amarāvati.

This relationship certainly existed, and is pointed out by Huien-Tsiang in the phrase transmitted by his biographer, that the king of the country, before building those monuments, "thoroughly investigated the rules and patterns of Tahia."² This phrase would not be quite intelligible, had not a strong group of Pahlavas originally coming from the country of Tahia been at hand. How could that king who built and decorated the *stūpa* and their Buddhist monuments, "thoroughly investigate the rules and patterns of Tahia" being himself nearly two thousand miles off? Or must we suppose that he dispatched a messenger to that country to conduct that thorough investigation on his behalf, or perhaps a group of architects and stone-cutters to study those rules and assimilate those patterns? It was not so difficult for him to conduct

1. Smith, *op. cit.*, p. 155.

2. Mr. K. de B. Codrington, *Ancient India*, p. 26, founding his statement upon Smith, *op. cit.*, p. 155, note 1, says that the word Tahia is the effect of "a mistranslation of Huien-Tsiang." It is not so. The MSS. used by Julien and Beal had *ta-hsia*, "which is a Chinese name for the country called Bactria"; while the MSS. used by Watters had *ta hsia*, "a great mansion". Watters, *On Yuan Chwang's Travels*, II, p. 218. There is, therefore, a slight difference in the MSS. which makes a great difference in the meaning of the passage. Now the reading adopted by Watters does not seem quite appropriate, as, according to it, Huien-Tsiang compares two Buddhist monasteries to one "great mansion". The version of Julien and Beal is more logical, and to those who know the historical circumstances presents no difficulty.

such an investigation, having as he did a strong group of the Parthian nation settled next to him ever since the wars between the Andhras and the Kshatrapas.

The original *stūpa* of Amarāvati dates from the second century B. C., just the time when the *stūpa* of Jaggayyapeta was also built. But towards the middle of the second century A. D., the *stūpa* underwent considerable transformation, a new encasement with carvings and decorations and a railing being erected round the old structure. These are the sculptures admired by Huien-Tsiang, in the seventh century, some of which are now exhibited in the British Museum and some Museums in India, and have been discussed above. Under what king or kings was this restoration of the primitive *stūpa* done?

From the inscriptions found on the slabs of the *stūpa* itself, we now know that the restoration works were carried out under three kings of the Andhra Dynasty, *viz.* Śrī Puṣumāvi, Śrī Svāmaka Śata and Śrī Yajña.¹ These three kings are Puṣomāvi IV, Śiva Śkanda Śātakarṇi and Yajña Śrī Śātakarṇi, who according to Smith ruled successively.² According to the *Purāṇas*, there is another king differently called, after Puṣomāvi IV³, but he is given a short reign; and the similarity of his name, Śivaśrī or Śātakarṇi Śivaśrī, with that of his successor Śivaskandanāga Śrī as given in a Banavāsi inscription,⁴ raises the suspicion that the same king is twice mentioned in the Purāṇic lists under different names. In any case, the period during which the Amarāvati *stūpa* was restored and decorated was from Puṣomāvi IV down to Yajña Śrī. This was precisely the period of Pahlava influence over the Andhra Kings. Puṣomāvi was twice defeated by Rudradāman and, as a consequence of these defeats, his kingdom was undoubtedly diminished and Pahlava settlements were established in these new Kshatrapa possessions. Yajña Śrī was the king who adopted the Kshatrapa type of coinage, which reveals a new and utter defeat inflicted on him by the same enemies of his family. During this period of Pahlava influence in Southern India, there were evidently architects and stone-cutters who had either themselves been in the north-western Pahlava kingdom, or learnt from their fathers the "rules and patterns" in force in that part of the country. These men were apparently not only consulted by the king, but (perhaps)

1. Burgess, *The Buddhist Stūpas of Amarāvati*, pp. 5, 61, 100

2. Smith, *E. H. I.*, p. 232, chart.

3. Cf. Rapson. *op. cit.*, pp. lxi-lxvii.

4. Bühler, *The Banavasi Inscription of Hariputa-Satakarni*, *I. A.*, XIV, p. 334.



Portrait of Simhavishnu at Mahāballipuram

(*Adhivārāha temple*)

actually employed in the decoration of the *stūpa* ; and they carried out their commission so successfully that nearly two thousand years afterwards their work bears witness to the cunning of their hands and the secret of their origin.

10—THE PALLAVA THRONE

One of the carvings of the Adhivarāha temple of Mahābalipuram shows king Simhavishṇu seated on his throne. This throne, a very interesting piece of furniture, undoubtedly represents the Pallava throne. Elsewhere I have described it as a three-legged throne.¹ Mr. Krishna Sastri was not sure whether the throne was supported by three or four legs, for, after mentioning its three legs, he prudently adds a sign of interrogation.² As a matter of fact, only the front legs are seen, and seem to be artistically carved in the shape of lions' legs, for which Krishna Sastri calls that throne "the Pallava-*siṃhāsana*".³ Yet, the ordinary Indian *siṃhāsana* is not so called because its legs imitate the legs of a lion, but because its legs "are made up of four small lions".⁴ The height of any *āsana* is not much, only a few *aṅgulas*, sometimes four, sometimes eight or ten *aṅgulas*. An *aṅgula* being the measure of a fingerbreadth, is equivalent to three fourths of an inch.⁵ Hence an *āsana* ten *aṅgulas* high will rise only six inches above the floor. The height of a throne according to the *Mānāsara* varies, if we take into account all the different kinds of thrones existing in Ancient India, from 9 *aṅgulas* to 23 *aṅgulas*. Therefore, the highest possible Indian throne would be 16½ inches above the floor.

We have a good representation of a throne in ancient India on

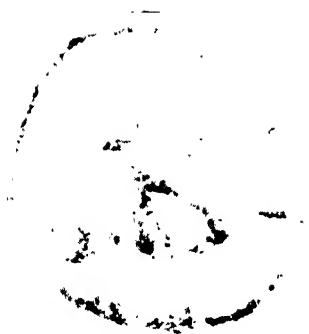
1. Heras, *Royal Portraits of Mahabalipuram*, *Acta Orientalia*, XIII, p. 165.
2. Krishna Sastri, *Two Statues of Pallava Kings and five Inscriptions on a Rock Temple at Mahabalipuram*, p. 2 (M. of A. S. of India, No. 26.)
3. *Ibid.*
4. Gopinath Rao, *Elements of Hindu Iconography*, 1, p. 21. These lions had to be represented standing on their hind legs, just as we see them carved on pillars of many Hindu temples. The famous throne of Vikramāditya was thus supported and surrounded by the thirty-two statuettes of maidens ; "the throne was mounted by putting the foot on the heads of these statuettes". Edgerton, *Vikrama's Adventures*, I, p. 18.
5. Gopinath Rao, *Kings, Crowns and Thrones in Ancient and Mediaval India*, *The Modern Review*, p. 159.

the coins of Samudragupta, of the Lyrist type. The king is seated on the throne, cross-legged, but one of his feet rests upon a stool. Now this stool is higher than half the height of the throne. This proves that the throne itself was very low.

If that is so, the throne of *Simhaviṣṇu* in the *Mahābalipuram* carving is not a throne according to the Indian canons. It is a high throne, as high as the leg of a man from the knee down to the foot, for *Simhaviṣṇu* is seated in the *sukhāsana* fashion, resting his right foot upon the floor. To this circumstance the shape of the legs of the throne may be added, which does not seem to be much in accordance with Indian custom. What was the origin of this new type of royal throne introduced by the Pallavas in Southern India? Once more, the solution of this puzzle will be found in the North Western territories of Hindustan.

During my recent tour through Afghanistan, I acquired two coins of the Kushāna king Huvishka, which seem to contain the clue to this mystery.¹ The king is seated on a throne resting his left elbow on a cushion placed on the throne itself, while his right foot is also placed on the throne *à la négligé*. The two specimens are extraordinarily different in their workmanship: No. 1, found at Bēgram in Kohistan, on the site of the ancient city of Kapiśa, is a beautiful specimen, though naturally worn out. The king's pose is quite natural; his broad shoulders strikingly contrast with the thinness of his waist. His tunic is distinctly seen falling from the right leg and forming into folds. One also notes that the right foot touches the ground. No. 2 shows very poor workmanship. It was acquired in the Kābul bazar. The figure of the king, though placed in the same position, has no shape at all. The shoulders are of the same breadth as the waist. The arms and legs appear like twisted sticks, and though he is supposed to lean on his left elbow there is apparently no cushion to lean on.² Yet, in spite of this extraordinary difference in workmanship, probably pointing two different mints, the throne does not vary at all. It is the throne of the same style as the throne of the *Mahābalipuram* relief, though perhaps a little broader. But the

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1. Many Museums possess coins similar to these acquired by me in Afghanistan, but the specimens reproduced in the Catalogues are not clear enough. The Prince of Wales Museum in Bombay has two excellent specimens. The seat of the king is generally called a couch.
 2. The specimen illustrated in Whitehead, *op. cit.* pl. XIX, No. 182 is similar to No. 2. The illustration of this coin in this *Catalogue* is not properly placed.



King Huvishka
seated on a Greek throne
(Coin found at Kapisa, Afghānistān ;
L. H. R. I., St. X. C.)



King Huvishka
seated on a Greek throne
(Coin found at Kābul, Afghānistān)
(L. H. R. I., St. X. C.)



King Huvishka
seated on cushions in Indian fashion
(on one of his coins)



King Samudra Gupta
playing the *vina* on a throne
(Lyrist type of his coins)

All magnified two diametres)

legs, which are the most characteristic feature of *Simhaviṣṇu*'s throne, are absolutely of the same shape ; one cannot see the lion's paw at the end, but may easily guess it from the doubly bent shape of the leg. Moreover, this throne is not a low throne, as imagined by Indian artists. The height of the throne is such as to allow the king to be seated on it and rest his foot on the floor without having to bend his leg. The Pallava throne, as represented in the Mahābalipuram carving, which is not according to Indian models, was then, a copy of the throne used by the Kings of the north-western territories of India.

It may be objected that, Huvishka having reigned in the north of India towards the close of the second century, that is, about one century after the expulsion of the Parthians from the country, the Pallavas could hardly have imitated his throne when they carved one for their own king in the South, as they had never met Huvishka. Here, we must remember what we have said previously, that the Kushāṇas, lacking in organised monarchical institutions, easily accepted the institutions of the country they conquered. The throne represented on the coin of Huvishka is, undoubtedly, a Greek throne. It was evidently the throne of Hermaios, the last Greek king of Kabul, who reigned for some time together with Kujula Kadphises, as their joint inscriptions on coins clearly show.¹ When, later on, Kadphises reigned alone, he continued using the same throne that, in turn, was used by his successors. But when these kings took possession of the whole of Northern India, with their proverbial eclecticism, they adopted, with other things, also the Indian throne. And thus it is that some coins of king Huvishka show him squatting on a low throne among cushions.²

At the time when Kujula Kadphises succeeded Hermaios in Kabul, the Parthians were ruling in the valley of the Indus, with Taxila as their capital. It is well known how they were Hellenized by the neighbourhood of Greek kings and through ruling over a country partly Hellenized : the Greek inscriptions and the deities engraved on their coins are a sufficient proof of it. They also undoubtedly adopted the throne of the Greeks as well as their art with much else. Therefore, the throne of *Simhaviṣṇu* is a reproduction of the Greek throne, which had already been used by the Parthian kings of the Northern Punjab. Thus the beautiful carving of Mahābalipuram wonderfully confirms the Parthian origin of the Pallava family.

1. Cf. Whitehead, *op. cit.*, pl. XVII, No. 8.

2. Cf. Whitehead, *op. cit.*, pl. XIX, No. 194.

CONCLUSION

In the course of this paper we have followed the steps of the Parthians, expelled from Northern India by the Kushāṇas, down to the south and the neighbourhood of Andhradeśa. The link between those Pahlavas and the Pallavas that shortly after appeared in Andhrapatha has been traced not from the similarity between the two names; but from several other circumstances summarised below :

1. The two ancestors of the Pallavas, Pallava and Koṅkaṇika, of the Bahūr Plates of Nṛipatungavarman, seem to show the way by which the Pahlavas of the North Western Frontier finally appeared as Pallavas in Southern India. Pallava is Suviśāka, the Pahlava Governor of Saurāshṭra, and Koṅkaṇika, one of his descendants who settled in Koṅkaṇ and finally moved towards the east.

2. The first Parthian leader to be raised to royal dignity after the Parthian settlement in the South was Virakūcha, who obtained this status by his marriage with a Nagā princess. His son defeated the last Andhra King Satyasena=Swāmi Śri Chaṇḍa Sāta.

3. The Pallavas were regarded as racial enemies by the great South Indian dynasties.

4. The title *Mahārājādhirāja*, adopted by Śivaskandavarma = Kumāravishṇu after the conquest of Kāñchi, is a Parthian title.

5. The Pallavas were extremely eclectic just as the Parthians of Northern India. The very name Pallava is another proof of this Pahlava eclecticism and of their tendency to Indianization. The change of Pahlava into Pallava, far from being a mistake, was subordinated to a definite purpose.

6. The Pallavas claim to be Brāhmanas while the Brāhmanas of the South recognized them only as Kshatriyas.

7. The Pallava coins show the symbols of the sun and the moon, first introduced in their coinage by the rulers of Persia and also used by the Parthian rulers of Malwā and Saurāshṭra—the Kshatrapas.

8. The Pallava *lāṇchana* is a bull, the same as the *lāṇchana* of the Kshatrapas, which was inherited from the coins of the Parthian rulers of Northern India.

9. The sculptures of Amrāvati and of other places in Andhradeśa reveal the influence of the so-called Gandhāra School ; a fact that is confirmed by Huien-Tsiang.



A slab from the Amarāvati Stūpa showing a Greek throne

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10. The Pallava throne represented in the portrait of *Simhavishṇu* in the *Adhivarāha* temple at *Mahābalipuram* is of the Greek type used by the kings of the north-western territories in the beginning of the Christian era.

By showing the value of all these Parthian relics found after seventeen centuries among the scanty data referring to the early Pallavas of South India, I have not propounded a new theory of my own. I have only tried to substantiate an old theory, to which I was formerly opposed. The strength of these ten proofs cannot certainly be challenged if each proof is taken by itself; but their cumulative force is even greater. This extraordinary agreement among data of such different nature as the royal title and the art of the country, the dynastic device and the throne, as well as the circumstance of their caste, cannot but point to the truth that lies behind all, that the Pallavas of South India are descendants of the Parthians that had settled in Northern India during the first century B.C.

THE RISE OF MUNICIPAL GOVERNMENT IN THE CITY OF AHMEDABAD

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The rise of municipal government in Ahmedabad carries one back to the early history of the British occupation of the City. For our purpose, however, we need not enter far into it. It will suffice, for the sake of a starting-point, to note one interesting fact emerging from its pages. The fact is that the historic walls of the City were, however remotely or indirectly but undeniably, responsible for the inception of early municipal administration in Ahmedabad.

It happened this way. The walls of Ahmedabad had suffered to no small extent from the vicissitudes of conquest the City experienced during the closing years of the eighteenth and the early years of the nineteenth century. When finally in 1817 the City passed into the hands of the East India Company and Mr. J. A. Dunlop, Collector at Kaira, went and took over formal possession of it on the 30th of November of that year from the official representative of the Gaikwar who held it till then, the walls were discovered by him to be in an extremely ruined condition. In Mr. Dunlop's words, the walls with a circuit of nearly six miles "had parts all around in complete ruin".¹

Now the value and importance of town walls in those days as a means of protection of life and property in normal times, apart from their military utility, could not easily be gainsaid. At the moment of the transfer of Ahmedabad to the British their value and importance as such were particularly enhanced by the unfortunate circumstance that Mr. Dunlop had been unable, through shortage of men, to provide himself on his departure from

1. Letter dated 2nd December 1817. from Mr. Dunlop to Mr. Chief Secretary Warden : Secret Dept. Diary, 303 of 1817, pp. 2543-48, *Vide* also Mr. Dunlop's Letter, dated 17th December 1817 : Revenue Cons., 7th January 1818, Revenue Dept. Diary, 126 of 1818, pp. 33-45.

Kaira with an adequate force for police or military needs of the newly-ceded City.¹ Nor was any reinforcement forthcoming from the quarters to which he addressed himself.² Such an unforeseen juncture made him look to the City's great girdle of masonry, which had protected it for centuries, to fulfil in some measure the purposes of troops and police which were not to be had in sufficient strength. But to serve those purposes efficiently the walls had of course to be put in a proper state of repair. Consequently, he made persevering efforts to interest the Bombay Government in a plan for the restoration of the City Walls. On two occasions surveys and reports were made and financial estimates submitted as directed by Government, but nothing tangible came of these³. The time appears to have been inopportune for ambitious undertakings like the one sponsored by Mr. Dunlop and Government declined to shoulder the financial responsibility the execution of the particular project would have entailed.

The favourable moment came nearly a decade later when Government was free to turn to broad measures of general welfare. In July 1830 Mr. Dunlop (now Revenue Commissioner) revived the question of restoration of the town walls. It seems that previously he had sounded the leading men of the City and fortified himself with their acquiescence in the necessity of repairing the walls. The fact enabled him to place his proposals before Government in a form that invited willing attention. His main proposal related to the important problem of securing the requisite finances for the work contemplated. The scheme would have probably received short shrift if Government had been called upon to bear or participate in the pecuniary burden of it. So, avoiding that fatal rock on which many a brilliant project foundered in the days of John Company, Mr. Dunlop made for a safe and simple principle of fiscal policy which could commend itself to a stinting Government.

The principle was that a public work of the kind recommended by him should be paid for by the citizens themselves who were to benefit by it. Mr. Dunlop suggested, in accordance with their wish, the enhancement of the town duties levied on certain

1. Mr. Dunlop's letter dated 2nd December 1817: Secret Dept. Diary, 303 of 1817, pp. 2543-48.
2. Minutes, 12th December 1817: Secret Dept. Diary, 303 of 1817, pp. 2553-54.
3. *Vide* Proceedings, Revenue Dept. Diaries, 127 of 1818, pp. 1375-89; 128 of 1818, pp. 1814-19; and 2005-08; 129 of 1818, pp. 2397-99; and Public Dept. Diary, 433 of 1819, pp. 1849-50 and 1896-98.

important commodities to an extent sufficient to yield twenty or thirty thousand Rupees per annum. He calculated that by that means an annual fund could be formed "sufficient to accomplish the work in the course of a few years". The management of the fund so raised and the execution of the work as well were to be entrusted to a mixed Committee of Government servants and the leading men of the two principal communities in the City. It may not be uninteresting to note in passing that the proposal of placing the work in charge of a committee subject to remote supervision by Government instead of in sole charge of the latter emanated from Mr. Dunlop's notion—no doubt a well-founded one—that "the people seemed unanimous in thinking our mode of conducting public works most expensive"¹.

There could not be any great difficulty in the formation of a Committee as suggested and, in fact, a Committee was soon appointed on the 22nd of April 1831.² This was the famous Town Wall Fund Committee from which the present Ahmedabad Municipality claims to derive its commencement. But the proposed increase of town duties did present an important difficulty at the very outset. Luckily, it was of a technical nature, capable of being overcome by a resort to the large armoury of Government's legislative powers. The question that arose was whether the levy of additional town duties would require a new enactment and further, granting the necessity of a new enactment, whether that would again require the sanction of the Home Authorities (the Court of Directors) to render it operative. It was decided, however, in consultation with the Advocate-General, that, as it was not proposed to exceed the maximum duties authorised by the Customs Regulation extant at the time, it was competent to Government to pass and put in force a new enactment raising the town duties in Ahmedabad without the previous sanction of the Directors in England.³ A little after, a scheme for the levy of the requisite duties was decided on with the active aid of the Collector of Customs, Gujarat, and embodied in a draft enactment.⁴ That

1. Extract of Letter from Mr. Dunlop, dated 20th July 1830: General Dept. Compilation, 245A of 1831-42, pp. 115-19.
2. Letter No. 1104 dated 22nd April 1831 to the Ag. Judge of Ahmedabad and others: General Dept. Compilation, 4/223 of 1831, p. 70.
3. *Vide* Extract from Secretary's Memorandum, dated 28th October 1830: Revenue Dept., 12/293 of 1830, p. 198; and Proceedings, General Dept. Compilation, 245A of 1831-42, pp. 123, 127-28, 131-32, 135-36.
4. *Vide* Proceedings, General Dept. Compilation, 245A of 1831-42, pp. 139-79.

draft enactment, after undergoing certain modifications in its language at the hands of the Sudder Dewanny Adawlut or the Company's Supreme Civil Court in Bombay¹, was passed as Regulation XII of 1831 on the 6th of July of that year². It was styled appropriately enough "A Regulation for providing funds for the repair of the City Walls of Ahmedabad."

The title no less than the actual provisions were clearly indicative of the scope and purpose of the Regulation. To begin with, the Regulation authorised the creation of a fund by levy of fixed import and export town duties, in addition to those which already existed, on particular commodities scheduled therein. Though the sum to be raised was about Rs. 30,000 per annum, yet the commodities subjected to taxation for the purpose were not a few in number. Thus an import town duty was levied on groceries and spices of all sorts (which came to 223 articles), sugar and sugar candy, molasses, cotton cloths, tutenague and ivory at the rate of one per cent; on silk raw at the rate of one and half per cent; and on ghee at that of two and half per cent. Again, a uniform export duty of half per cent. was imposed on cloth cotton, silk, silk and thread, and "Gurbh soot". But it is noteworthy that the levy of those duties was not intended to be permanent, at least not to the extent originally specified. For, it was clearly provided that when the outlay for general repairs, including charges intermediately incurred, had been recovered, the export duty mentioned above was to cease, and so much only of the import duty was to be retained as might be considered sufficient by Government "to defray the Expense of keeping the City Walls in good condition". There were also other provisions of minor importance regarding the mode of collecting the duties and keeping accounts thereof, which need not be reproduced in detail here.

Proceeding from the Regulation to the Town Wall Fund Committee which was designed to carry it into effect, it may be mentioned that it was a small but mixed body of Government servants and leading citizens appointed by Government. The purely official side of the Committee was represented by the Judge and the Principal Collector of Ahmedabad and the Collector of Sea Customs in Gujarat. On the other hand, an element of quasi-popular representation was introduced by the inclusion of

1. Letter, No. 129, dated 19th May 1831 from the Bombay Sudder Dewanny Adawlut to Secretary to Government : *Ibid.*, pp. 185-86.

2. Minute, 6th July : Judicial Dept., 26/240 of 1831, p. 113.

the Kazi¹ and the Nuggershet² (city-chief or alderman) of the City. The duties of the Committee were those of control and management of the Town Wall Fund and of general superintendence over the contractors who were to be employed by it for making the repairs. In the latter part of its duties it was assisted by the Government Inspecting Engineer in Gujarat who was directed to act as inspector of the work "in order that no impositions may be practised by the contractors using inferior materials or making defective work³".

The Committee presumably lost no time in setting to work and by October 1831 had concluded contracts with two persons of the name of Jaitah Kussulji and Moolji Girdhur for repairing a portion of the town wall. The portion first taken in hand and in respect of which the contract was given to Jaitah Kussulji for a sum of Rs. 31,672 (the work to be completed within one year) was that extending from Khanpoor Gate to Delhi Gate, including Shahpoor Gate; while Moolji Girdhur was entrusted with the repairs of Astoria Gate for a modest consideration of Rs. 1,375 coupled with a stipulation requiring him to complete the work in four months⁴.

Later on, however, it was found necessary to dispense with the method of employing contractors and from May 1833 the work was carried on under the immediate management of the Committee itself, assisted as before by the Inspecting Engineer⁵.

1. He was the hereditary Kazi of Ahmedabad, whose family had held that office for about 400 years dating from the Mahomedan times. Several members of the family rendered yeoman service to the East India Company. The Kazi himself was Law Officer of the Ahmedabad Adawlut for 22 years and resigned his post on account of physical infirmity to be succeeded by his son, Mahomed Hoossein Oodeen Kazi. His brother, Goolam Ruza, was made Fouzdar of the City by Mr. Dunlop in 1817 on the accession of the British and in that capacity served the Company for 27 years, contributing much to the maintenance of peace and order during the trying days of the beginning of the new regime. An uncle of his, Nawab Sadrul Huk Khan, was Fouzdar of Murshidabad in Bengal in the time of Hastings....*Vide* Mahomed Hoossein Oodeen's Petition to Sir George Arthur, Governor of Bombay, without date: Revenue Cons., No. 27, Revenue Dept., 196 of 1845, pp. 203-06.
2. The Nuggershet was Seth Hemabhai Vakhatchand.
3. *Vide* Letter No. 1104 dated 22nd April 1831 from Govt. to Ag. Judge of Ahmedabad & ors.
4. Letter from Committee to Secy. Bax, dated 17th October 1831: General Dept., 4/223 of 1831, pp. 80-81.
5. *Vide* Letter, dated 2nd May 1833, from Committee to Secy. Bax and Proceedings thereon: General Dept., 3/274 of 1833, pp. 165-69.

Bit by bit the Committee proceeded with its work the completion of which took well-nigh a decade. The task was an useful but uneventful one and it must be admitted the Committee's activities during this period can form no arresting chronicle. It was not till 1840 that there was foreshadowed the change which was to liberate its resources for a wider field of activity.

The change consisted in an augmentation of the Committee's functions which gave it the true colour and complexion of a municipal institution. It came about in the following manner.

On the 31st of October 1842 the Committee reported to Government the completion of the task assigned to it¹. But, some time prior to that date, and in anticipation of the event, a proposal had been advanced by Mr. Giberne, Acting Judicial Commissioner for Gujarat and the Conkan, that the surplus of the Town Wall Fund, after deducting the recurring charges for maintaining the City Walls in good and proper condition, should be utilised for conferring on the City of Ahmedabad certain municipal amenities of which it stood in serious need. Of those the two particularly stressed at the time were the supply of water to the City and the watering of the principal thoroughfares to allay the dust for which Ahmedabad has earned a name in history². Official opinion endorsed Mr. Giberne's proposal for the diversion of the Town Wall Fund to municipal purposes³. In particular, the Collector of Ahmedabad, Sir R. K. Arbuthnot, appears to have attached great importance to Mr. Giberne's suggestions for the improvement of the condition of the roads, and he requested the sanction of Government to the expenditure (from the general revenues, if the constitution of the Town Wall Fund did not permit of it) of a sum of Rs. 1,000, being the estimated initial expense of procuring water carts, as well as of Rs. 300 per mensem for maintaining an establishment of men and bullocks⁴.

But the main difficulty was that Regulation XII of 1831 was too restrictive in its wording, scope and intent to permit of an alienation of the Fund to any other object than the one originally

1. Letter, dated 31st October 1842, from Committee to Secy. Morris : General Dept. Compilation, 12/637 of 1842, pp. 241-42.
2. *Vile* Extract paras 50 and 51 of Mr. Giberne's Report dated 18th February 1840 and Govt.'s Proceedings thereon : General Dept. Compilation, 245A of 1831-42.
3. Letter, dated 4th March 1841, from Revenue Commissioner to Secy. Reid, with accompaniments dated 9th and 24th February 1841, *Ibid*.
4. Letter/ No. 1/ dated 14th January 1841 from Sir R. K. Arbuthnot to Secy. Morris : *Ibid*.

prescribed by it. Moreover, as we have already noted, it required the major portion of the duties levied under it to be done away with on the completion of the repairs to the town walls. That legal impediment could only be overcome by a new enactment which the Bombay Government was not competent to pass after the centralisation of legislative authority in the hands of the Government of India under the Charter Act of 1833¹. Legislative authority and legislative sanctions now proceeded from the high gods of officialdom at Calcutta. So the Bombay Government adopted the safe and obvious step of submitting the question to the Government of India and requesting it on 26th April 1841 to decide whether it would prefer to pass an act "legalizing the Expenditure of the surplus of the Town Wall Funds on the roads etc." or, pending a solution of the general question of retention or abrogation of all Town Duties which was at the time under the consideration of the Government of India, to sanction the outlay suggested by the Collector of Ahmedabad for watering the roads of the City².

The Government of India gave no clear-cut decision on the immediate issue submitted to it. It contented itself with offering suggestions. It did not consider a legislative enactment necessary. Instead it suggested, and it was a fair and fruitful suggestion, that the question should be settled with reference to the wishes of the inhabitants with whose assent and privity the Town Wall Fund had been originally brought into existence. It also suggested the abolition of the export duty in the spirit of Section 3 of Regulation XII of 1831³. The latter suggestion does not appear to have commanded as much attention as the former on the part of the Bombay Government which directed its local officers in Ahmedabad to ascertain the wishes of the inhabitants on the subject⁴. This took some time as the people were reluctant to express themselves

1. The Government of India Act, 1833 (3 and 4 Will. 4, c. 85) Sec. 59 ;
 ".....Provided that no governor or governor in council shall have the power of making or suspending any regulations or laws in any case whatsoever, unless in cases of urgent necessity (the burthen of the proof whereof shall be on such governor or governor in council), and then only until the decision of the governor-general of India in council shall be signified thereon."
2. Letter/ No. 1374/ dated 26th April 1841 from Bombay to Govt. of India : General Dept. Compilation, 245A of 1831-42.
3. Letter/ No. 174/ dated 18th October 1841 from Govt. of India to Bombay: Ibid.
4. Letter/ No. 3568/ dated 25th November 1841 to the Revenue Commissioner : Ibid.

in the matter in the absence of their Nuggershet who was then temporarily away from Ahmedabad. After his return the leading citizens who were consulted laid down, in a yadi or memorandum dated 14th June 1842¹, what seems to have been the common desiderata with reference to the subject brought under their consideration.

The document just mentioned, brief and business-like as it is, is interesting and deserves a word to itself. It not only expresses, from the orthodox popular point of view, the municipal needs of the City in those days, but evinces that shrewd eye for economy of ways and means which is the hall-mark of a very influential section of the Hindu community of Ahmedabad. It appears from the memorandum that the representatives of the people, or at least those considered as such, were not averse to the continuation of the Town Wall duties for certain municipal and charitable works. Those works as specified by them were : (1) the construction of a reservoir for the supply of water to the City from the river ; (2) the building of a Dhurumsala, and (3) a Grain Market ; and (4) removal of the filth collected in the vicinity of the gates. With respect to the rate and extent of levy, they suggested that, after the completion of those works, the import duty on ghee, goor (molasses) and tamarind might be abolished and the import and export duties on the rest of the articles reduced by six annas in the Rupee or by such amount as would leave an income sufficient to meet the charges on account of certain objects for which they desired permanent provision to be made, *viz.* for (1) keeping in repair the Town Walls and the reservoir, Dhurumsala and Grain Market above alluded to ; (2) watering the principal roads ; (3) maintaining establishment for drawing water for the reservoir ; and (4) creating an endowment for feeding the poor.

All those suggestions or proposals, except the last relating to endowment for feeding the poor, gained the approval of the Bombay Government which was prepared to embody them in an enactment intended to alter or replace Regulation XII of 1831.² But it is doubtful whether the contemplated enactment reached even the stage of a preliminary draft, for certain extraneous events to be noted presently seem to have had the effect of keeping in abeyance the proceedings of Government on the subject.

1. Letter / No. 1018 / dated 15th July 1842 from Revenue Commissioner to Chief Secy. Reid, with Letter No. 37 dated 21st June 1842 from Ag. Collector Fawcett to Revenue Commissioner and Yadi enclosed : *Ibid.*
2. *Vide* General Dept. Proceedings / No. 3024 of 1842 / and Resolution dated 30th August 1842 : General Dept. Compilation, 245 A of 1831-42.

At least, no such draft of the proposed Act is, so far as the present writer knows, traceable among the official records.

The reason was, as already hinted, that at that point the birth-throes of a general municipal policy embracing the entire British India of the time overshadowed municipal questions of minor, local importance such as the one which arose in Ahmedabad. The question of a general municipal policy was first broached by the Government of India in 1836 when the Town Wall Fund Committee seems to have been absorbed in no more ambitious achievement than the restoration of the town walls. On the 30th of May of that year the Government of India wrote to the Bombay Government : " The attention of the Supreme Government has recently been attracted to the question of providing means for carrying into effect such municipal improvements as may be necessary or desirable for the security or comfort of the numerous opulent and populous towns throughout India. It has occurred to His Lordship in Council, that as the town duties have now been given up within the Presidency of Fort William in Bengal, the inhabitants of the large towns may fairly be called upon to contribute to defraying the expense of such improvements as are required for their own convenience ; and that within the Presidencies of Fort St. George and Bombay (where the town duties have not yet been given up) it may be proper that a portion of that impost may be reserved, when the boon that has lately been granted to the towns of the Presidency of Fort William in Bengal may be extended to those of Fort St. George and Bombay". And the Bombay Government was asked to collect information on certain salient points and to submit a general scheme of municipal taxation on the basis of it.¹

It was the question of a suitable form of municipal taxation for the Bombay Presidency which occupied a central place in the investigations and discussions that followed. It may appear from the above quotation that the Government of India, whilst desirous of abolition of the town duties, was not averse to the levy or reservation of a portion of those duties for municipal purposes exclusively ; but that was not so, as it took care to explain later on.² So, when the Bombay Government, after prolonged enquiries, submitted on 22nd June 1840 a scheme in the shape of

1. Letter/No. 42/dated 30th May 1836 from Government of India to Bombay : Judicial Dept., 32/476 of 1838, pp. 1-2.
2. Letter/No. 91/dated 5th March 1838 from Government of India to Bombay : Revenue Cons. No. 14, Revenue Dept., 93 of 1838, pp. 237-42.

a draft act providing for the abolition of the existing town duties and for their re-imposition for municipal purposes on a modified system calculated to remove the odious and oppressive character of the one prevalent,¹ the Government of India turned down the scheme, deeming the total abolition of the town duties and allied taxes essential for the relief of the people and remarking that "in no modified shape can these imposts be established without leaving a permanent load on industry and production, such as extreme financial pressure only could justify". At the same time, in order to compensate for the deficiency in revenue that was certain to be caused by the proposed abolition of the obnoxious taxes, the Supreme Government offered to raise by a legislative enactment the excise duty on salt from the prevalent rate of eight annas to twelve annas per Indian maund.² As regards taxation for municipal purposes, the Supreme Government suggested the levy of a house-tax assessed on rents, and the suggestion was perhaps a natural one in view of the fact that a short time previously it had passed Act X of 1842, legalising this form of taxation for carrying out municipal improvements in the towns of the Bengal Presidency.

This led to further inquiries and investigations on the part of the Bombay Government, which wanted to have a clearer view of the practical applicability of the several suggestions of the Government of India to the local conditions of the various parts of the Presidency.³ On broad principles very little difference of opinion, if any, was perceptible between the two Governments. Bombay was at one with Calcutta on the necessity of abolishing the multifarious, oppressive cesses and taxes on trades and professions and of substituting in their stead a uniform tax like the salt tax. It was also in agreement on the question of making some legislative provision for enabling revenue to be raised for municipal purposes and even the idea of a house-tax for those purposes was not unacceptable to it. In a word, there was little or no disagreement in respect of the substance or extent of the reforms contemplated. There was a difference of emphasis rather than of views between the two Governments. What the Bombay

1. Letter/No. 2054/dated 22nd June 1840, with accompaniments, from Bombay to Government of India : Revenue Cons. No. 26, Revenue Dept., 133 of 1840, pp. 263-65.
2. Letter/No. 15/dated 8th March 1843 from Government of India to Bombay : Revenue Dept., 103 of 1843, pp. 131-36.
3. *Vide* Minute, dated 9th May 1843 : Revenue Cons. No. 19, Revenue Dept., 103 of 1843, pp. 139-42.

Government laid particular emphasis on was the mode of carrying into effect the reforms in question and the adaptability of the general measures founded on those principles to the actual condition of the people, which varied with different parts of the Presidency. As regards the former, the Bombay Government wanted simultaneous legislation respecting the abrogation of the injurious taxes and substitution of the enhanced salt tax on the one hand and the creation of a source or sources of municipal revenue on the other. It desired both those measures to be treated as parts of one great act of reform to be carried out at one and the same time. As regards the latter, the Bombay Government came to the conclusion that one uniform method of municipal taxation, whatever its theoretical advantages, was not suitable to the Presidency. Its views ultimately crystallised in two draft acts, one of which provided for the abolition of the town and similar other duties and enhancement of the salt excise duty and the other embodied a scheme for bringing into existence municipal bodies wherever necessary. These were forwarded to the Supreme Government on 6th August 1844 with a request to give them legislative effect simultaneously after due consideration¹.

But it is doubtful whether the communication of the Bombay Government on the subject received attention at the moment². The Government of India, wishing perhaps to delay no longer what it considered an important measure of finance, passed Act XVI of 1844 on the 27th of July of that year (without intimation to the Bombay Government) whereby the tax on salt within the Bombay Presidency was increased to one Rupee per Indian maund from the 1st of September³, though it may be worth mention at the same time that it was shortly afterwards reduced to 12 annas at the instance of the Court of Directors. The enactment in question, in imposing additional taxation without corresponding relief from other imposts and levies which it was originally intended to replace, came like the proverbial cart before the horse with truly unfortunate consequences.⁴ It caused in many parts of the Presidency a great deal of unrest which took a particularly serious

1. Letter/No. 2583/dated 6th August 1844 from Bombay to Govt. of India: Revenue Cons. No. 28, Revenue Dept., 135 of 1844, pp. 21-42.
2. Letter/No. 62/dated 14th September 1844 from Govt. of India to Bombay: Revenue Cons. No. 38, Revenue Dept., 135 of 1844, pp. 127-29.
3. *Vide* minute, 16th August 1844.
4. For an explanation of the precipitancy with which the Act was passed, *Vide* Letter/No. 71/dated 19th October 1844 (paras 4-6) from Govt. of India to Bombay: Revenue Cons. No. 48, *Ibid.*, pp. 241-50.

turn in Surat, where riots broke out. As a palliative to the muddle created by the Salt Act, the Bombay Government provisionally suspended, pending a reference to Calcutta, the collection of town duties and kindred taxes by a proclamation of 7th September 1844 which contained however an exception in favour of those taxes which were strictly appropriated to municipal purposes'. The local Government was thus mindful of the interests of such incipient municipal organisations as happened to exist. But the Supreme Government, on the other hand, came very near terminating their existence, for it seems to have been stampeded by reports of the situation that had arisen out of the promulgation of the Salt Act into suddenly passing Act XIX of 1844 which did away, at a stroke and without exception or qualification save one, with all town duties and taxes on trades and professions in the Bombay Presidency. It was as terse in the announcement of its purport as it was sweeping in its effect; for it ran: "It is hereby enacted, that from the 1st day of October 1844, all Town Duties, Kusub Veeras, Mohturfas, Ballootee Taxes and Cesses of every kind on Trades or Professions under whatsoever name levied within the Presidency of Bombay, and not forming a part of the Land Revenue, shall be abolished"². It brought about, among other things, the automatic repeal of Regulation XII of 1831.

These proceedings furnish no flattering commentary on the insight or imagination either of the Government of Bombay or of the Government of India. For one, their measures failed to carry the people with them, because the authors of those measures carried their heads too high to gauge the popular feelings aright. But, as rulers are slow to blame themselves, the failure to evoke any enthusiastic response from the people was construed as indifference or apathy on the part of the latter to municipal improvements. The indifference or apathy towards the measures of Government was no doubt there and figured conspicuously in official reports³; but the real reason for it appears to have been different from what Government or its

1. Revenue Dept., 135 of 1844, p. 49.

2. Ibid., p. 131.

3. *Vide*, for example, Letter/No. 535/dated 9th April, 1842, from the Revenue Commissioner, W. Simson, to Secy. Morris, summarising the views of the Collectors of the various districts on the draft municipal act forwarded by the Govt. of India to the Bombay Govt. on 2nd August 1841 and subsequently passed as Bengal Act X of 1842. The Collector of Ahmedabad alone welcomed the proposed legislation. General Dept., 2/627 of 1842, pp. 159-64.

officers conceived it to be. The particular trait owed its existence to a circumstance for which Government itself was in a great degree responsible. While professing, undoubtedly sincerely, to do something towards the amelioration of the material lot of the dwellers in towns and cities, it was apparent beyond question that the one overwhelming anxiety of Government at the same time was that the people should pay or be made to pay to the pie for whatever of amenity or comfort they might be able to secure through its instrumentality. It is in consequence not difficult to understand why measures which threatened to add to, or at best make some substitution for, the admittedly heavy load of taxation should have led to no sympathetic popular response or, if at all, to a sporadic angry response, however much these might be glossed over with the appearance of being intended for the people's welfare. Ahmedabad, for instance, felt itself constrained to forward a protest on the occasion of the publication of the Bombay Government's draft act in 1844 for raising revenue for municipal purposes.¹ The oft-noted indifference or apathy of the people was mostly the result of superficial observation which found it easy to blame the quarter where it was known protest was generally mute.

The antagonism of popular sentiment to Government's methods and measures, which mostly exhibited itself as a passive indifference to them, goes far to account for the poor results of some of the best-intentioned plans of the authorities. The hasty legislation of the Government of India referred to above is an illustration in point. Whatever the importance or effect of the twin statutes, Acts XVI and XIX of 1844, as purely revenue measures, they appear a piece of legislative futility in their intended bearing on the municipal questions of the day. And not only were they a mere failure as such, but a failure with definitely deleterious consequences.

In the first place, Act XVI of 1844, in consequence of the excitements and disturbances that followed in its wake, seems to have caused the Government of India to recoil from undertaking municipal legislation for Bombay, as it would have involved the imposition of some tax or the other. The question of municipal improvement in Bombay was left alone for a time.

1. Petition to the Governor in Council, dated 25th September 1844: Revenue Dept., 132/1689 of 1844, pp. 129-34. *Vide* remarks thereon in Revenue Commissioner's and Ahmedabad Collector's Letters No. 1297 dated 22nd October 1844 and No. 126 dated 2nd October 1844: *Ibid.*, pp. 123-25 and 127-28.

In the second place, Act XIX of 1844, by its indiscriminate abolition of all town duties etc., cut off or threatened to cut off the already existing means of such feeble municipal improvements as were carried on in Ahmedabad, Gogo, Dhollera, Solapur and Nasik with the aid of certain portions of those levies which were reserved for municipal purposes. For one, we have seen that Act XIX of 1844 repealed Regulation XII of 1831 under the aegis of which the Town Wall Fund Committee had been able to obtain the sinews of municipal administration. To complete the stagnation, a further bar was put up in the shape of the opinion of the Government of India, communicated to the Bombay Government on the passing of Act XIX of 1844, that municipal charges should not be disbursed out of the general revenues of the state. Acting on that opinion, the Bombay Government adopted a resolution to afford "no assistance for the improvement of the towns under this Presidency, unless the inhabitants themselves come forward with reasonable contributions". Thus not only was general municipal legislation delayed, but whatever of local means of municipal administration existed was swept away by "the stream of general abolition".

The Bombay Government, however, managed to rescue certain municipal funds which were of respectably long standing by persistently representing to the Government of India the useful purposes they served and the consequent necessity of maintaining them¹. Among those thus rescued was the Ahmedabad Town Wall Fund. Pending a reference to Calcutta in regard to it, the Local Government issued on 19th November 1844 instructions to the local officers to the effect that the tax might continue to be collected as before, if it was paid voluntarily "without dispute", distinctly forbidding at the same time the use of any compulsion for recovering it².

- 1 *Vide* Letters/Nos. 3364 and 3645/dated 2nd October and 18th October 1844 respectively from Bombay to Government of India: Revenue Department, 135 of 1844, pp. 119-30 and 141-44. Letter/No. 78/dated 26th October 1844 in reply from Government of India to Bombay : Ibid., pp. 181-82.
2. Letter/No. 1146/dated 21st October 1844 from Collr. of Continental Customs and Excise to Secy. Townsend : Revenue Dept., 135 of 1844, pp. 155-56. Govt.'s Reply dated 19th November 1844 No. 4045 : Ibid pp. 159-60. For a neat summary of the whole proceedings and correspondence of the Bombay Govt. upto November 1844, on the subject of town duties and municipal funds *vide* Revenue Dept., 135 of 1844, pp. 253-324.

Thus the Town Wall Fund was saved, but it no longer stood on its old footing. Stripped of legislative sanction, it became a voluntary contribution rather than an authentic or legally enforceable tax. In view of this it is notable that it continued to be levied and paid and enabled the Town Wall Fund Committee to look after the municipal needs of the City for the next fourteen years or so. During the period from 1842 to 1858 the Committee commenced or carried out important municipal works, such as the city water-supply, the maintenance and lighting of roads, and scavenging and sanitary arrangements. In the troubled days of 1857-58 it was called upon to maintain, which it did, an auxiliary force of 400 Seebundies or Watchmen for the protection of the City¹. In this it may be said to have anticipated to some extent Bombay Act I of 1871, which later on obliged the municipalities to contribute towards the maintenance of the police employed in towns and suburbs.

It is however necessary to state here in order to prevent any misapprehension that the system of town wall duties did not remain unchanged throughout the existence of the Committee. The duties seem to have undergone revision on more than one occasion. But a substantial reform was introduced as late as August 1851. The necessity for it was made only too plain by the abuses that had crept in. It was noticed that at least one-third of the amount of the collections was lost through collusion on the part of the subordinate agents who were badly paid and inadequately supervised. Further, large annual remissions were granted to the Nuggurshet and other influential men whose opulence could have easily borne their quota of the burden². It was also admitted that the incidence and the method of taxation had proved to be heavy and vexatious³. Accordingly, as a measure of relief, the duties on 217 out of the 223 articles on grocery, spices, etc. were totally abolished and the duty of one per cent. retained on the remaining six articles. Moreover, a fee of one per cent. was agreed to be levied on the tariff price of imported cotton yarn and two rupees on every chest and three rupees on every cask of cochineal imported into the City. Silk and ghee continued to be taxed at the rate of one and a half and two and a half per cent. respectively. Lastly, the rate of duty

1. Proceedings, General Dept., 61 of 1857, pp. 323-39 and 57 of 1858, pp. 111-27.
2. *Vide* Extract para 12 from Letter from the Collector of Ahmedabad, dated 18th April 1850: (General Dept., 62 of 1850, pp. 377-78.
3. *Vide* Minutes: *Ibid.*, p. 380.

on jagree or molasses was altered from one per cent. to one anna per jar or pot and half a rupee per cart load, and the method of collecting it was modified so as to obviate the harrassment and annoyance to importers caused by the former practice of taxing the article at the Custom House where it was first carried to be weighed and valued¹. The reforms were introduced without the formal sanction of Government, as such sanction could not be legally given².

We come now to a period which marks, so to speak, a new era in the municipal history of Ahmedabad. At this period the Committee, from being a body with a narrow and none too well defined constitution, was merged in what may be called the prototype of a municipality on modern lines. It was no longer to be a loose municipal organisation primarily indebted for its existence to popular initiative favoured and backed by the authority of Government, but one which was a product of Government's legislative efforts for the creation of a municipal system in the country and owning a more sharply defined allegiance to the authority which created it.

The year 1858 witnessed the end of the Town Wall Fund Committee and the substitution of a "municipal commission" with well-defined constitution and powers. The municipal commission in question was established by virtue of Act XXVI of 1850, passed by the Government of India on 21st June 1850 and styled "an Act to enable improvements to be made in Towns". The circumstances under which the Act came to be passed may be briefly touched upon here.

We have mentioned how the hasty measures of 1844 were followed by a brief interval of stagnation as regards Government's activities in respect of municipal legislation. But towards the end of 1848 the necessity for such legislation was convincingly brought home to the Bombay Government by the spontaneous outburst of municipal activity witnessed in the Belgaum Collectorate, under the encouragement and guidance of

1. Letter/No. 17/dated 28th July 1851 from the Ahmedabad T. W. F. Committee to Secy. Lumsden: General Dept., 16 of 1851, pp. 9-11.
2. Letter/No. 3431/dated 26th August 1851 from Government to the President, T. W. F. Committee: General Dept., 16 of 1851, p. 13. It does not therefore appear to be quite correct to say as Pratt does at p. 18 of his "Memorandum on Municipal conservancy in the Districts of the Bombay Presidency, Sind and Sattara" (edn. 1856) that "a further revision of the original system of taxation was authorised by Government in August 1851."

Mr. J. D. Inverarity, the Collector. "These proceedings", to quote an official report, "afforded such satisfactory evidence of the willingness and ability of the people, under judicious direction and assistance, to undertake and carry out local improvements within their own districts, that it was considered of importance to obtain the early sanction of the legislature to the formation of municipalities in the provincial towns of the Bombay Presidency; and under these circumstances every possible opportunity was taken by the authorities.....urgently and forcibly to draw attention to the want of adequate legislative provision for the systematic prosecution of measures of municipal reform"¹. And in the result the Government of India was successfully persuaded to pass the Act previously referred to.

That statute, though possessed of a certain historical importance as a piece of early municipal legislation, was a halting measure clearly designed as a half-way house between the desire to confer the boon of municipal institutions and the fear of popular opposition. Its language and provisions betray a rather lively anxiety on the part of its framers to avoid offending the susceptibilities of the people. Nothing perhaps better exemplifies the spirit in which this act of legislation was undertaken than the preliminary procedure laid down by it for the formation of municipal bodies. The onus of establishing municipalities was shifted from the initiative of Government to the voluntary enterprise of the people. It embodied the "voluntary principle", which ruled out the inception of municipalities by the direct and primary agency of Government. Under the Act, if the people of a town were desirous of possessing municipal amenities, they had in the first instance to make an application to Government calling upon it to permit them the benefit of the Act by declaring it in force in their town. Government was in its turn required to ascertain the genuineness of the application by giving public notice thereof through the Government Gazette as well as through a proclamation in the town in question, calling upon the people at large to declare themselves for or against the introduction of the Act. A reasonable time, generally fixed at two months, was allowed for that purpose; and if, after the lapse of it, Government came to the conclusion on the strength of such declarations of assent or dissent as might be before it, that the original application really reflected the wishes of the people in the matter, it made and duly published a final order declaring the Act in force wholly or

1. Pratt's Memorandum on Municipal Conservancy in the Districts of the Bombay Presidency, etc., p. 14.

partly as the general wants and circumstances of the people might call for.¹ Needless to say no such order would or perhaps could be made if the public verdict was clearly adverse to the imposition of the Act.

The next important step after these preliminary formalities was the appointment of a commission, composed of the Magistrate and such number of townsmen as might be deemed necessary, for "putting the Act in force" and vested with authority to frame rules "for more effectually accomplishing the purposes" for which it was appointed². This "commission" was in those days the municipality of the town in which it was set up. It is noteworthy that under the Act the requisite municipal revenue could be raised (though the provision was not inserted without the persistent representation of the Bombay Government on the point and the consequent amendment of the original draft of the Act) either in the form of a House Tax or of Town Duties or in any other form deemed suitable to local circumstances and prescribed in the rules framed by the commissioners³.

In the case of Ahmedabad the first "municipal commission" was not appointed till about seven years after the passing of the Act. It may sound somewhat strange that a City, accustomed so long to the benefits of a municipal organisation, should have thus delayed in taking advantage of the Act. But the official records seem to afford an explanation which clearly points to the remissness of local officers as responsible for the delay. It appears that a good number of townspeople, including their leaders in wealth and social position, were persuaded, through the efforts of Mr. Samuel Mansfield, Acting Magistrate of Ahmedabad, to present a petition to Government praying for the application of Act XXVI of 1850 to their City. The petition was dated 12th August 1852. It is interesting to note in passing that the petitioners expressed no uncertain aversion to the enforcement of the Act being made the means of new or increased taxation, the town duties to the tune of Rs. 30,000 annually collected by the Town Wall Fund Committee being deemed sufficient for all municipal purposes. Reading between the lines, the main object which the petitioners seem to have had in mind was to obtain through the instrumentality of the Act, without additional expense to the citizens, a better constituted and regulated and more responsible body

1. Act XXVI of 1850, Secs. ii-iv.

2. Ibid., Sec. vi.

3. Ibid., Sec. vii (2).

than the existing Committee for coping with the growing municipal needs of the City¹.

On receipt of the petition Government caused a notification to be published as required by law in the Government Gazette on 8th September 1852²; but, for some reason, probably through an oversight, the requisite public notice of the purport of the application was not given by proclamation in the City. The omission was pointed out on 3rd March 1853 by a Mr. Hadow, the successor of Mr. Mansfield³. Thereupon that officer was directed by Government to "issue the usual notice allowing the inhabitants of the Town of Ahmedabad two months to make their declaration for or against the introduction of the Act"⁴. But nothing further was heard of the matter till February 1855 when, in reply to Government's demand for an explanation of the delay,⁵ Mr. Hadow forwarded a rather elaborate disquisition on the impediments and difficulties in the way of the formation of a municipal commission⁶. But his circumlocutions failed to satisfy Government which directed him once more to issue the necessary proclamation and submit the names of those who might be deemed fit to be appointed commissioners⁷. The proclamation was accordingly issued on 17th March 1855, but Mr. Hadow did not trouble himself to apprise Government of the fact for a considerable time. Eventually he seems to have been urged into informing Government of it on 27th October 1856 by a severe reprimand for "carelessness and inattention" to official duties⁸. At the same time, as no objection on the part of the people to the introduction of the Act had been made known within the prescribed period of two months, Mr. Hadow also requested the final order of Government declaring the Act in force in the City of Ahmedabad and submitted the names of thirty persons for

1. General Dept., 12 of 1852, pp. 75 and 77-78.
2. Ibid, pp. 83-84.
3. Letter/No. 89/dated 3rd March 1853 from Mr. Hadow to Secy. Lumsden : General Dept., 55 of 1853, pp. 161-62.
4. Letter/No. 1038/dated 29th March 1853 to Mr. Hadow : Ibid., p. 165.
5. Letter/No. 369/dated 25th January 1855 from Government to the Magistrate of Ahmedabad : General Dept., 53 of 1855, pp. 172-73.
6. Letter/No. 81/dated 3rd February 1855 from Mr. Hadow to Secy. Hart : Ibid., pp. 176-94.
7. Resolution, 6th March 1855 : Ibid., pp. 196-98.
8. *Vide* Proceedings: General Dept. 66 of 1856, pp. 1-4.

appointment as municipal commissioners¹. The upshot of it was the Resolution of Government dated 11th November 1856, followed by a Public Notification of 14th November, declaring Act XXVI of 1850 in force in the Town of Ahmedabad from the 1st of January 1857 and constituting a municipal commission of the persons named by the procrastinating Magistrate².

But the chapter of delays was not to end there. The municipal commission was no doubt called into legal existence in 1857, but it could not really begin to function till the rules, which it was required by the Act to frame, had received the sanction of Government. These were submitted by the commissioners as early as May 1857, but much time was lost in their passage through several departments of Government for scrutiny, and especially in the department of the Police Commissioner, a hardened, old-time conservative of those days, who finally submitted a memorandum containing narrow and reactionary views on the subject of municipal self-government in India and suggesting certain modifications in the rules in keeping with the character of his views. A liberal spirit was however abroad among the superior authorities, who brushed aside the recommendations of the custodian of peace and order³. The formal sanction of Government was therefore available to the Municipal Commission about the month of April 1858. Till that time the old Town Wall Fund Committee carried on municipal duties as before.

The next important landmark in the growth of the Ahmedabad Municipality was its reconstitution in 1873 under the Bombay District Municipal Act (VI of 1873) which superseded Act XXVI of 1850. The new Act made a fundamental departure in principle from the preceding one in that it gave Government a power of direct initiative in the creation of District Municipalities. The "voluntary principle", under which the authorities were supposed to wait and watch for some tangible exhibition of the popular desire for municipal amenities before conferring the boon of a municipality on a district, was given a go-bye to. Instead, the Governor of Bombay in Council was empowered to notify as a "municipal district" any place where a municipality might be deemed necessary, and thereupon to establish a municipality there, subject of course to the right of the inhabitants to object⁴.

1. Letter/No. 872/dated 27th October 1856 from Mr. Hadow to Secy. Hart: General Dept., 66 of 1856, pp. 35-38.
2. Ibid., pp. 43-46.
3. *Vide* General Dept., 53 of 1858, pp. 466-79.
4. Act VI of 1873, Sec. iv, cls. 1-2.

A further noteworthy feature of the new Act was its classification of municipalities into two kinds, *viz.* City Municipalities and Town Municipalities.¹ The distinction had a two-fold basis. It rested first on the difference in the nature and power of the commissioners constituting the municipalities. In the case of City Municipalities the entire power and responsibility for carrying out the objects and purposes of the Act was vested in the Commissioners collectively, subject to certain restrictions². In the case of Town Municipalities the power and responsibility were finally vested in the President (who was under the Act the Collector of the District) and in the Vice-President (who was the Assistant or Deputy Collector in charge of the Taluka) subject to appeal to the President either by the other Commissioners or by the public or any individual considering himself aggrieved³. The distinction was further founded on numerical considerations, since no City Municipality could be constituted in any district containing a population of less than 10,000 inhabitants and no Town Municipality in a district of less than 2000 inhabitants.

But Government observed a further distinction in putting the Act into actual operation. It sought to invest City Municipalities with an enhanced status by recognising the right of a district to have one in its midst only on proof of its fitness for self-government. A Resolution (No. 1631) of 11th June 1874 in the General Department intimated in the form of instructions to the Collectors and other local officers that "Government will not create City Municipalities without clear evidence that the population in general, and their representatives, the existing Municipal Commissioners, have, by their intelligence and adoption of sanitary and other improvements, as evinced by the state of their City, established a claim to superior powers of self-government"⁴.

In the City of Ahmedabad the municipality existing under Act XXVI of 1850 was constituted into a "City Municipality" by a Government Notification dated 7th November 1874 in the General Department.⁵

An interesting event that followed close on the inception of the remodelled Municipality deserves mention here as evincing the existence of the popular interest in self-government. In the

1. Act VI of 1873, Sec. vi.

2. Ibid., Sec. viii, Cl. 1.

3. Ibid., Sec. x, Cl. 1.

4. General Dept., 36 of 1874, pp. 93-95.

5. Published in the Bombay Government Gazette Extraordinary of the same date: General Department, 36 of 1874, p. 263.

case of city municipalities, Section VII, Clause 2 of the Act gave a limited recognition to the elective principle in the constitution of municipal bodies by providing that the Governor in Council might, if he thought fit, direct the whole or any portion of the non-official commissioners to be appointed by election. But at the outset Government had no inclination to give effect to the principle of election. The people of Ahmedabad, on the other hand, wanted it. They deemed themselves fit for democratic self-government and were anxious to welcome it even in the meagre form permitted by the Municipal Act. A petition, dated 21st June 1874, and signed by Dayabhai Anopchand Nuggershet and a large number of citizens, requested Government "that the provisions of Section 7 of the District Municipal Act, so far as they relate to the introduction of the elective principle, may be made applicable to the City Municipality of Ahmedabad." Among the grounds urged were that "the system of selection by Government" had proved unsatisfactory and that the City of Ahmedabad offered a fair field for experiment with the principle of election. "We venture and are glad to say," the petitioners stated, "that by the extent and population of our ancient City, by the wealth, commercial enterprise and general intelligence, education and business habits of our fellow Citizens we possess among us several persons duly qualified by education and intelligence and public spirit to look after our local municipal affairs. Indeed we should not look upon it otherwise than as an undeserved reproach to our City if Government after the legal recognition of the elective principle refused to extend its application to us, for there must be at least twenty wise and qualified persons in a population of a lac and twenty thousand"¹.

But the official opinion of the day was none too favourably disposed to the introduction of elections in the country. The Collector of Ahmedabad, Mr. Borrodaile, was against it on principle as he considered election "one of the greatest shams of the day" and its extension to India dangerous². And Government on its side seems to have been influenced by the fact that an experiment with elections had not proved satisfactory in the City of Bombay³. The consequence was that the earnest prayer of the petitioners was politely turned down⁴.

1. General Dept., 37 of 1874, pp. 107-08.
2. Letter/No. 924/ dated 18th July 1874 from the Collector of Ahmedabad to Govt. : General Dept., 37 of 1874, p. 111.
3. Memorandum/ No. 1357/ dated 24th July 1874, from Police Commissioner, N. D. : Ibid., pp. 112-13.
4. Resolution/ No. 2658/ dated 12th September 1874 : Ibid, p. 117.

It may be well, however, to note in conclusion that what was refused at the time was vouchsafed ten years later during the regime of a Viceroy justly popular for the liberality and independence of his views.

Thus far we trace the rise of the Ahmedabad Municipality from a small official body to a fairly representative institution. Its subsequent development and occasionally stormy career belong to recent history and do not precisely fall within the purview of the present article.

B. K. BOMAN-BEHRAM.

CONCILIATION AND ARBITRATION

Co-operation is a vital essential for the reconstruction of modern industry. Injustice, want of sympathy, misunderstanding and suspension have been the marked features of industrial relations, particularly in India. This unhealthy atmosphere is due to mistaken attitude of both workers and employers. As regards the industrial workers, co-operation has received adequate recognition at their hands for regulating their mutual relations; it is taken as a moral duty. But this very principle which ought as well have been logically applied for regulating the relation between labour and capital has been discarded by the workers under the influence of Marxian doctrine. Marx declared that capital was derived from profits obtained by paying labour less than the value it created. Thus according to Mark Capital has no place in the process of production and the capitalist is a bandit who holds up to ransom the whole world of workmen. He lets labourers off with their lives on conditions that they hand over to him the entire value of their labour, keeping for themselves a share just enough for maintenance. It is that Marxian sophistry which has been largely responsible for labour troubles in this country, particularly in Bombay. To this must be added the attitude of the employers holding fast to crude individualistic notions of industry, to the idea that a workman is an economic unit without soul, sensibility, ideals or aspirations, who still labour under the discredited obsession that justice and sympathy are incompatible with discipline. This type of employer has failed to recognise that capital, enterprise and manual labour play separate and distinct roles in industry. He looks upon himself as all-dominant personality and labour as his feudal and dependent hireling. To this in short is due the industrial strife and labour unrest. In what follows we propose to examine the nature of machinery provided for regulating industrial strife.

A critical study of the modern industrial life makes it clear that the seeds of industrial disputes are sown in the divorce in ownership of the instruments of production from actual producer. It is not surprising, therefore, to find this phenomenon assuming more striking proportions with the growth of mass production with its unhealthy repercussions in body politic. In the primitive stage of industrial production the problem of industrial relations is almost absent. But the moment separation

between the producer and the instruments of production crept in and there came the master craftsman owning the instruments of production and his apprentices having no claim to such instruments, we discern the seeds of industrial strife. This condition was aggravated with advent of factory system and large scale production, when the relation of the employer and the employee came to be firmly established in industrial production. Strong organisations of labour and capital sprang up as an essential condition of the industrial organisation. As a matter of fact capitalist production forced labourers to organise; insecurity, victimisation and unhealthy working conditions being the propelling force. As a result of organisation based on the motive of self-help, not only have the labourers become vocal in voicing their grievances and educating the public opinion as to their needs, but they have succeeded in making their demands effective. Their success in this sphere has varied with the strength of their organisation as modern industrial history teaches us. Improved labour conditions are the fruits of organised strife. Narrow self-interest has been coerced to give way before the demands of justice. The industrial abrasions manifest themselves in the form of strikes and lock-outs. Both a strike and a lock-out mean a dispute and disagreement on the terms of employment. The essential distinction between the two forms lies merely in the fact as to which party has taken the first step in the offensive.

When labour and equipment in the whole or any part of an industry are rendered idle by a strike or lock-out, the national dividend must suffer in a way that injures social welfare. The loss of output for which these disputes are responsible often extends much beyond the industry directly affected. The reason for this is that a stoppage of work in an important industry checks activity in another industry or industries in two ways. On the one hand, by impoverishing the industrial workers actually involved in the stoppage, it lessens the demand for the goods turned out by other industries; on the other hand, if the industry affected supplies a commodity or service largely utilised as raw material by other industries, it causes a serious dislocation to such industries. The magnitude of the loss thus suffered will vary according to the importance of the commodities or service supplied by these industries. Thus for instance, a miners' or railway servants' strike will produce a much larger indirect effect than a cotton workers' strike of the same extent and duration. But in some degree, all stoppages of work inflict an indirect injury upon the national dividend by the reactions they set up in other industries, in addition to the direct injury that they carry in themselves.

From the foregoing it is clear that the friction must be reduced in order to get maximum production. It may be to the immediate advantage of an employer or a trade union to fight the dispute to a finish, but to the community, a single day of stoppage of work is a loss. The conflict between sectional interests is not conducive to national welfare, as will be evident from the facts portrayed in the preceding paragraph. Hence, if the parties concerned are unable to come to an amicable settlement and thereby prevent the occurrence of industrial disputes it is the duty of the State to intervene in the interests of the society.

In view of the immense loss caused by the industrial disputes, several remedial measures have been devised by the industrially advanced countries intended to avert the occurrence of these industrial and social catastrophes. These measures attempt to reduce the number as well as the intensity of the industrial disputes; they are essentially remedial rather than preventive measures. This is so because in the modern construction of society, complete elimination of the friction between the employer and the employee is an impossibility. "We are convinced," says the Whitley Report, "that a permanent improvement in the relations between the employers and the employed must be founded upon something other than a cash basis." Notwithstanding this essential feature of the modern society, attempts have been made to reduce the number as well as the intensity of these conflicts and in these measures conciliation and arbitration have played an important part.

Conciliation

Voluntary agreement is the essence of conciliation. The basis on which conciliation rests is the mutual understanding of each other's point of view. In short, conciliation functions in the reign of reasoned persuasion for one of chaos in industrial bargaining.

Instead of fighting out each issue by a trial of strength, conciliation supplants the supremacy of reason where parties succeed according to justice of their claims. Thus conciliation makes for industrial peace. Mr. Cole says: "It takes no sides but merely tries by measuring strength, to replace conflicts by peaceful settlements. The peace it presupposes is the peace not of the two parties but of the community at large. A settlement by conciliation is or may be as much a trial of strength as a strike. It is a method of comparing resources—of which public support may, of course, form part—in order to avoid a trial of endurance between profits and stomachs or purses. Such conciliation may be applied to any branch of labour in which a conflict, a trial of strength

between the parties may arise; but not elsewhere. It is the diplomacy of industrialism and differs only in that it may easily take a permanent form.¹”

Conciliation has assumed different forms. Of these different forms the one of note is where attempts are made to settle differences between the contesting parties before they assume proportions. This is termed the Joint Industrial Council method. In its second form conciliation attempts to tackle disputes after they have come to the fore. Here conciliation may be either optional or compulsory. The term compulsory conciliation, if it means the compulsory acceptance of the conciliator's findings, or decisions, is really a misnomer. If the acceptance of conciliator's findings is compulsory then it would be classed as arbitration. Compulsion and conciliation are two contradictions. If, however, by compulsory conciliation is meant that the contesting parties are obliged to meet when called upon by the conciliator to do so and to produce necessary documentary and other evidence, there is no reason to demur. Such system obtains in Sweden. Conciliation, therefore, is essentially optional. No wonder, therefore, if conciliation has acquired considerable importance in the settlement of industrial disputes. It has rightly taken the form of joint consultation. The representatives of each party sit together with a chairman either elected by themselves or appointed by the Government. The constitution and powers of these Boards vary according to the local conditions and requirements of the different countries. But when conciliatory methods do not succeed and the parties fail to arrive at an amicable settlement, the need for an outside agency to mediate between the parties is felt. In anticipation of this contingency, some States have made a provision for the appointment of public representatives on the Conciliation Boards. But, here too, the need for arbitration from the decisions of the Boards has been often felt. “Commonsense as well as the finer feelings of peace, humanity and equity, demand that industrial disputes, which cannot find amicable settlement between the parties immediately concerned must be submitted to an impartial Board or Court, whose award must, if the pressure of public opinion does not suffice for settlement, be made compulsory. This is the demand for what may be termed compulsory arbitration. It is based upon the principle that the settlement of trade dispute, being a social interest, demands a method of settlement compatible with that principle.”²”

1. *Vide*, G. D. H. Cole : “The World of Labour”, p. 48.

2. *Vide*, Hobson's “Conditions of Industrial Peace.”

Hence the need for arbitration. In addition to the usual material gain that would accrue to the parties referring their dispute to arbitration, there is an immense gain for pride and temper. It is a common practice that men who have backed their demands by threat and ultimatum find it difficult to retract to a half way position, even though they know that it would be better to do so. It would not be an exaggeration to say that the existence of a respected standing tribunal serves in industrial conflicts as the Hague Court of Arbitration between nations : it enables the parties to withdraw without loss of pride from a bellicose attitude¹. No wonder therefore if arbitration has come to hold a very important place in the settlement of industrial disputes. "The essence of arbitration is the existence of an authority specifically set apart to adjudicate on disputes under recognized conditions"².

Arbitration

Arbitration, as it has developed in more important industrially advanced countries, is either optional or compulsory. Where arbitration is optional, both parties agree to refer the dispute to arbitration, but the award is not compulsorily enforceable by definite penalties. It is more akin to conciliation. Under compulsory arbitration, however, parties have perforce to submit their case to arbitration and the awards are enforced either by imposing penalties or by preventing the stoppage of work. It behoves us, therefore, to examine the legislative provisions made in this connection in more important countries.

The legislative provisions made in Great Britain for eliminating friction and discord between labour and capital should be noted. The Industrial Courts Act of 1919 is instructive to study. The Act provides for the establishment of a permanent Industrial Court consisting of representatives of employers and workmen, with a president who is a person of independent standing. The members are appointed by the Minister of Labour, some of whom devote their full-time attention while others are selected when required to serve in cases as they come up for decision. Here, however, it is important to note that the president is a full-time officer with intimate knowledge of industrial relations and as such exercises invaluable personal influence on the combating parties in enabling them to come to an amicable settlement. The industrial Courts Act provides that all possible resources of conciliation

1. *Vide*, Taussig : "Principles of Economics", Vol. II, p. 345.

2. Gilchrist R. N. : "Conciliation and Arbitration", p. 10.

should first be exhausted before arbitration is resorted to. It lays down that "if there are existing in any trade or industry any arrangements for settlement by conciliation or arbitration of disputes in such trade or industry made in pursuance of an agreement between organizations of employer and workmen the Minister of Labour shall not unless with the consent of both parties to the dispute, and unless there has been a failure to obtain a settlement refer the matter to arbitration."¹ Thus, it is clear that arbitration is only resorted to when all efforts at conciliation have failed.

But the most important feature to note is that the proceedings before the Industrial Court are voluntary. The decisions of this Court are not enforceable. In other words there is no penalty imposed to compel obedience on those who refuse to obey the decision. The Industrial Court has commended itself both to employers and to the employed as a competent and impartial body. But at the same time, it cannot be denied that it has fallen short of requirements. There have been protracted disputes due to obdurate stand taken up by one of the parties. This entails considerable loss to the community. It has been suggested that after a time when the employers and the employed get more completely organized, the Act with suitable amendments and amplifications may be made to serve far better purposes. Firstly, the amendment should be to enable the Court to function on the application of either party. Secondly, the award should be made applicable to all workers engaged in similar industries in a given district. This will preserve equality of industrial conditions. Thirdly, legal sanction should be given to the awards. It may be submitted that the intervention of the Court on the application of one of the parties to a dispute would materially add to its usefulness. The knowledge of the facts invariably brought to the surface would have a sobering effect upon the employers and the employed. They would be more anxious to settle out of "Court." It should not, however, be feared that, because the Court is more easily accessible, it would be more easily used. That would depend upon the degree of efficiency and fair dealing in the industries concerned, and the extent of their ability to settle without resort to Court. Well organized industries with efficient machinery for the adjustment of differences seldom refer their matters to arbitration. It is in the case of less organized industries that the intervention of the State machinery is more frequently required. And these would be stimulated to put themselves in a

1. Survey of Industrial Relations, p. 263.

better position as publicity and impartial consideration become the alternative to secrecy and confusion. Employers and the employed might get greater sense of trade pride and there would be a legitimate outlet for individual self-expression for both in contributing to it. No doubt some safeguards would be necessary against frivolous cases being raised and the need would be met by making provision for a money deposit.

The New Zealand experiment is instructive as an example of compulsory arbitration. The Industrial Conciliation and Arbitration Act has come to imbibe the principle of compulsion. Any two or more Industrial Unions of either employers or workers in any industry may form an Industrial Association and register the same under the Act. Such registration enables any Union or Association to enter into, and file, an industrial agreement specifying the conditions of employment agreed upon. Further, in the event of a failure to arrive at an agreement to bring the industrial dispute before the Council of Conciliation and if necessary, before the Court of Arbitration. For the purpose of administration of the Act, the Country is divided into eight industrial districts, and in each district a Board of Conciliation is formed, consisting of five members, the union of employers and employees having the right to elect two members each, with a Chairman chosen by the four members thus appointed. The Court of Arbitration for the whole colony consists of a President, holding the status of a Supreme Court Judge, and two representatives elected by the Unions of employers and employees. The principle of compulsion was in its initial stages supported by the trade unions and strongly opposed by the employers. By the sponsors of the Act it was claimed that the Arbitration Court will not be very often called into requisition ; on the contrary, in 99 cases out of 100 in which labour disputes arise they will be settled by the Conciliation Boards ; but unless there is in the background an Arbitration Court, the Conciliation Boards will not be respected and they will be virtually useless. The subsequent events have, however, falsified the sanguine expectations of the sponsors of the Act. They failed to foresee that the Court could not remain a mere judge of a dispute between the parties to the dispute, but would be forced to become a regulator of the conditions of employment in every industry. Yet the assumption of these duties by the Court was inevitable, right from its very inception, if the employer directed by an order of the Court to improve the conditions of his workmen was not to be placed at a disadvantage in the competition with his foreign rivals. Thus, 'the Act' in practice resulted in the State regulation of industry.

The Arbitration Court can be invoked by either party in a dispute if the Council fails to reach a settlement. The award should be made within a month. In that case strike or lock-out or their instigation is punishable with fine or imprisonment. And the Court can also determine the penalty for violation and the extent to which the award could be applied inside or outside the ranks of those immediately represented. But the parties are left to give effect to the awards or again to invoke the law by civil proceedings if necessary. The law also prohibits strike or lock-out in a related industry while a case is under consideration. A live wage is considered the first charge on an industry and the books of a firm or company can be examined in camera by a judge, who could fix the share of the profits of an industry to which the workers might be entitled.

AUSTRALIAN LEGISLATION

The Wages Board system of Victoria is an instructive illustration of an important form of compulsory arbitration. Industrial workers of Victoria in certain disorganized or weak trades were being exploited by the grasping employers and the wages were extremely low which aroused public feelings and concerted efforts were made to improve the conditions by making legislative provision for the protection of the industrial workers. The present Wages Board system has evolved out of several tentative legislative efforts made in fixing the minimum wages.

The Special Board consists of equal number of representatives of employers and employees, but the number of members thus appointed must not be less than four or more than ten, and all must have been bona fide and actual employers or employees in the trade concerned for at least six months within three years previous to being appointed. These members are appointed for a term of three years but they are eligible for re-appointment. The members have to elect their own chairman, but if they fail to do so within fourteen days after their appointment, the appointment is made by the Governor in Council. The Chairman is to be deemed a member of the Board.

The Boards are empowered to fix minimum wage and piece-work rates, regulate hours of work, proportion of juvenile workers, and special rates for the incompetent where it may seem just and expedient to do so. Decisions of the Boards called determinations are arrived at by a majority of members, and unless amended or revoked by the Court of Industrial Appeal come into force after thirty days. The determinations are published in the Government Gazette.

It is significant to note that even though the general principle of the minimum wage has been accepted, no attempts have hitherto been made to state precisely and definitely the principle whereby that minimum may be fixed. This failure seems to be due to the peculiar difficulties that the problem presents. Large discretionary power is, therefore, vested with the Boards and particularly with the Court of Industrial Appeal. "The various systems have been left, in the main, to develop themselves, in the hope that in the particular circumstances surrounding each case a principle of guidance would be supplied to those whose duty it was to interpret the spirit of the Acts.¹" It needs be pointed out that to the extent to which the minimum wage is fixed with the aid of conciliation the need for definite principles does not arise, but the same is not true of the case where the legal wage is fixed by arbitration. In the absence of definite guidance, the decision is apt to become arbitrary. Doubtless the authorities aimed to rely primarily upon conciliation but in practice it has been found that the Boards have failed to secure unanimity in their decisions and the casting vote of the Chairman is invariably used, evidently importing the element of arbitration. The success of the Wages Boards, therefore, depends upon the ability of the Chairman. The Wages Board system seems to be a compromise between a system of voluntary conciliation Boards with legal enforcement of agreements and a compulsory arbitration system. Further point of note is that no provision is made for the enforcement of the awards against the labour with the result that the workers support the award only when it secures for them better terms than they could themselves procure from the employers. Capital is denied such remedy against injustice.

Reviewing this compulsory system, Bryce remarks: "A review of the compulsory system as worked during the last fifteen years points to the conclusion that its failure to prevent strikes has been due to two causes, first that there could not be finality in the awards, the temptation to the Union leaders to make fresh demands soon after a rise in wages had been secured kept up irritation and uncertainty, and secondly that there was no means of compelling the wage earner to comply with the awards." Because "the introduction of penalties in the form of either imprisonment or fine is an illusory protection. If the organizations concerned are reasonable and inclined with a spirit of obedience to the spirit and letter of the law, neither imprisonment nor any

1. *Ibid*, M. T. Rankin: "Arbitration and Conciliation in Australia", p. 30.

other sanction is necessary. If the organization is strong, aggressive and unreasonable, the threat of fine or imprisonment will not be deterrent.¹"

Arbitration Act in New Zealand was not intended to prevent strikes, but to discredit them as national calamity. It is, however, contended that in its working, the Act, by fixing wages, by declaring strikes illegal, and by imposing fines and punishments, does actively seek to prevent strikes, and not merely to discredit them. Further, when strikes do occur, there is no provision to meet them and avert the national calamity. The provision of fines does not go far enough; it seems more in the nature of conciliation rather than arbitration. Under a system of compulsory arbitration the parties to the dispute should be compelled to carry on the industry under the awarded conditions. This the New Zealand system has failed to provide. The task is indeed extremely delicate and difficult. A system of arbitration cannot succeed in preventing strikes as can be seen from the New Zealand experience. Conciliation has proved to be the sole effective medium even in New Zealand because most of the strikes have been settled by mutual agreement between the parties concerned, ignoring the Arbitration Court and its awards; the nature of the terms of the settlements have varied according to the relative strength of the parties. In other words, the relative strength of the bargaining parties seems to be the decisive factor. Compulsory arbitration and State Regulation of Wages is effective only so long as it helps the workers and not beyond. It functions only in industries where labour is unorganized; when labour gets strongly organized and self-assertive, the system automatically collapses. This marks the limit of State regulation. Strike is a national calamity but not essentially criminal. Workers have a right to live; and live a high, rich and full life. So long as the labour is not accorded its right place in the industrial system and the industrial relations are incompatible with individual freedom, the labour will have the right to resort to strike as the effective weapon for their economic emancipation. Doubtless the community has a right to protection against the insecurity and privation resulting from the industrial strife, as has been repeatedly stressed by the protagonists of the prevailing system, but at the same time, there is a corresponding obligation upon the community to provide its labour force reasonable amenities of life, which is often conveniently ignored. The industrialists as well should have from this no cause for demur.

1. (*Vide* Modern Democracies by Bryce, Part II, 1920, P. 252.)

Contented labour force is an invaluable asset of the industrialist and cements the tie between the employers and his employees.

Canadian legislation may now be briefly noted. The Conciliation Act of 1900 created a Department of Labour and provided machinery for arbitration on a voluntary basis ; its help could be invoked if the parties to the disputes agreed. In 1903 Railway Disputes Act was passed which introduced for the first time the element of compulsion by empowering the Minister of Labour to appoint a Board of Conciliation in labour disputes between railway companies and their employees on the request of either of the parties to the dispute without consent of the other. In 1906, both these Acts were consolidated into Conciliation and Labour Act of 1906. The failure of the Conciliation Act to prevent strikes led to the passing of the Industrial Disputes Act of 1907. This Act was subsequently amended in 1910 and 1918. The Canadian Industrial Disputes Act of 1907, though it carries the element of compulsion a step further than the Conciliation and Labour Act of 1906, is essentially different from a compulsory arbitration law because it scrupulously keeps in tact the principle of voluntary adjustment. It needs be noted that this Act is applicable specifically only to transportation companies, other than public utilities and mines, but it can also be invoked for settlement of disputes in other industries on application of both parties to a dispute.

On a proper application by either party to a dispute in an industry covered by the provisions of the Act, the Minister of Labour has to appoint a Board of Reference consisting of one nominee of each party and a Chairman selected by the two. The Minister of Labour is empowered in case of a dead-lock both to select and appoint a Board. If settlement of a dispute is reached by the parties during the course of its reference to the Board, a brief memorandum drawn up by the Board and signed by the parties is filed with the Minister of Labour. If, however, they fail to arrive at a settlement, the Board is required to make a full written report to the Minister of Labour, setting forth the details of its investigation and its recommendations for the settlement of the dispute. The report is filed in the office of the Registrar and copies are sent free of charge to the parties and to any newspapers in Canada which apply for them. Compliance with the recommendations of the Reference Board is optional ; the weight of public opinion alone is relied on to make settlements effective. But if both parties to the dispute agree in writing to be bound by the recommendations of the Board, the findings become mandatory.

The Canadian legislation is thus based primarily on public opinion for its support and success. It has been rightly said that the theory of the Act is that the Board's findings, being based on what is presumed to have been a fair and impartial investigation, will bring an informed public opinion to bear on the matters which have been in dispute, and that either of the disputants who is unreasonable in his attitude will thus be induced to yield a point and accept the recommendation of the Board, rather than fly in the face of a public opinion which might be expected to sustain the view of the Board. Illegal strikes are penalised. But the penalty end of the Act is not emphasised; it exists as a possibility and exercises wholesome restraint on the industrial workers and their employers.

The Canadian Legislation has been on the whole fairly successful, though its legalistic manipulations have failed to inspire complete confidence of worker's and cause certain amount of friction. Where investigations have been most informally conducted, the recommendations have been backed by public opinion and accepted by the disputants. It has helped to crystalize public opinion and to make it effective for maintenance of industrial peace.

Thus compulsory arbitration has received only a qualified acceptance. Public has been inclined to support it because it affords protection against industrial strife. When properly enforced it provides an invaluable guarantee of industrial peace. Hobson says: "Public attitude demands that it shall be made impossible for any industry or other service, upon the regular functioning of which other great industries and even the subsistence of a whole people depend, to cease its operations because members quarrel about terms of employment. Rival groups must no longer be permitted to block the thoroughfares of industry and endanger the safety of peaceful citizens.¹"

Employers do not seem to favour the principle of compulsion because in the first place it limits their personal liberty and secondly the awards can more easily be enforced upon them than upon their employees. Further the employers contend, "that no outside authority can have the intimate knowledge of the business and their market, that is essential to a sound award, that an award imposed upon them will weaken their authority and the discipline necessary for the efficient conduct of their works, and that no settlement except one voluntarily reached by the parties concerned

1. (*Vide*, Conditions of Industrial Peace, p. 29).

will give any security against any future trouble.¹" But it should be noted that arbitration is simply a sword in the sheath, to be resorted to only when conciliation has failed to bring about a settlement.

The employers, however, do not stand alone in their opposition. Trade Unions have joined them partly because it restricts their right to strike but more so due to the shrewd suspicion that an arbitrator will have an unconscious class bias. As Hobson says, "the worker's right to strike is to him a matter of personal liberty. And if he has the right to say upon what terms he will work and to refuse work if he cannot get them, so he claims the right to take joint action with his fellow workers in the assertion of these rights. So the members of a trade union in an essential industry claim the right to take an action for the furtherance of their own legitimate interest, which damages the entire economic system and the life of the community, without these wider interests having any right of intervention."²

Further it is said that compulsory arbitration will be able neither to prevent a strike when a large body of industrial workers are determined to strike nor to force them to accept the award if they believe it to be unjust. Similarly, employers cannot be coerced to accept a scale of wage payments which the economic conditions of the industry do not warrant or to run a factory at a loss, as is clear from the Australian experience.

From the foregoing, therefore, it is clear that arbitration to be truthful must be voluntary. Mr. Clay rightly remarks, "If arbitration is to give us what we want from it, it must be voluntary, not compulsory, and the leaders of two sides must assume the responsibility of carrying out the awards they have invoked."³ Compulsory arbitration has far-reaching effects and what the outcome might be, it would be rash to predict. Professor Taussig says, "Compulsory arbitration, carried to the limit, does not content itself with defining the bounds within which competition shall work. It supplants competition. Wages, interest, profits, are to be determined by the bargaining of employers and employees with liberty to each party to desist at will and see how the other can get on without. They are to be fixed by public authority ; and this involves settlement by public

1. *Vide*, Hobson, Conditions of Industrial Peace, p. 32.
2. *Vide*, Hobson, p. 33.
3. *Ref. Problems of Industrial Relations*, p. 207.

authority of distribution of wealth.¹” It is feared that the institution of compulsory arbitration with the growth of democracy might lead to indefinite increase of all wages and curtail thereby the returns to investors and business-men, and an eventual check to accumulation and business enterprise. Further, it may lead to a trial of socialism. Few people realise that the scheme for compulsory arbitration points to changes so far reaching.

This should not, however, convey an impression that compulsory arbitration has no place in industrial relations. Far from it. Arbitration is a very valuable recognized substitute for stoppage of work. The precise degree of compulsion which it is found desirable to exert in such cases necessarily depends upon the attitude of the community in general, and of the organizations of employers and industrial workers in particular on whose co-operation the successful use of the compulsory measures very largely depends. Compulsion should, therefore, be such as to command the moral support of the community. In public utilities and sweated industries the principle of compulsion has been accepted.

From the foregoing review it is clear that the industrial world is moving more towards conciliation than towards arbitration. True, what can be achieved by discussion of arguments and the resulting conciliation of mutual claims, can never be achieved by forcing upon an unwilling party an award which it believes to be unjust. Therefore, in dealing with industrial disputes, all possible resources of conciliation should be exhausted before it is referred to arbitration. Even then arbitration should aim at clarifying the issues with a view to enlighten the public opinion. If public opinion fails to bring the disputing parties to terms arbitration would be proper substitute for the stoppage of work. Professor Gilchrist remarks, “The main issue in conciliation and arbitration is between force and voluntary methods. Compulsion has many advocates but the moment the temper of the world as a whole is hesitating between voluntary method and the modified compulsion of the Canadian Act. The more thorough compulsion of Australia does not seem to be gaining in popularity. Even in Australia there are signs that compulsion may be modified by the more democratic methods of Whitley Councils².”

CONCILIATION AND ARBITRATION IN INDIA

In the light of the foregoing review, let us now examine the provisions made in India for the regulation of industrial disputes.

1. *Vide*, Taussig : “Principles of Economics”, Vol. II p. 349.
2. *Vide*, Gilchrist, “Conciliation and Arbitration”, p. 221.

Prior to the passing of the Trade Dispute Act as an all India measure early in the year 1929, there was, with the exception of a conciliation panel in Bengal, no official machinery for conciliation and arbitration in industrial disputes in India. The Employers' and Workmen's (Dispute) Act, which was passed in 1860 to make provision for the speedy termination of certain disputes between workmen engaged in railway and other public works and their employers and which was extended to certain parts of the Bombay Presidency in 1860 and 1861 and to Sind in 1873, dealt with individuals and did not provide any machinery for the settlement of disputes in other trades and industries. This is not all. It also embodied the principle of criminal breach of trust. The Labour Commission, therefore, rightly recommended the entire repeal of this Act. The Act was accordingly repealed in March 1932. The only provinces in which ad hoc Committees have been appointed during the past fifteen years, either to enquire into the question of providing machinery for the settlement of disputes or to deal with specific strikes, are the Bengal and Bombay Presidencies.

Bombay Presidency

The first Committee to be appointed in the Bombay Presidency was the Industrial Disputes Committee appointed in 1921 with Sir Stanley Reed as Chairman "to consider and report on the practicability or otherwise of creating machinery for the prevention and early settlement of industrial disputes." The Committee found that the workers went on strike without having clearly defined grievances and thereafter often put forward extravagant claims. This was partly due to the lack of any effective organization among workers to formulate their claims. Notwithstanding these difficulties the workers showed marvellous spirit of endurance in vindicating their grievances. This Committee made several recommendations with regard to the standardisation of wages, trade unions, the attitude employers should adopt towards unions of their workers and the recognition of their unions, Works Committees, Welfare Work Co-operative Societies, housing of Labour etc. Their recommendations were intended to contribute to the preservation of industrial peace by preventing industrial disputes. With regard to the matter of settlement, the Committee recommended that no outside agency, and in particular the agency of the State, should be used until all other means have been employed and failed, or unless it is invited by one or other of the parties to the dispute, or unless the situation is such that peace, order and good government are prejudiced. If such conditions arise, then there should be formed an Industrial Court

of Enquiry, to be followed, if necessary by an Industrial Court of Conciliation.

In pursuance of the recommendations made by the Industrial Disputes Committee, the Government of Bombay published a Bill in the Bombay Government Gazette in May 1924. The Government of India, however, asked the Local Government not to proceed with the measure as they themselves intended to introduce similar legislation for the whole of India.

The next Committee to be appointed by the Government of Bombay was the Committee of Enquiry with Sir Norman Macleod as Chairman to enquire into the general strike of the Bombay Cotton Mill Worker of the year 1924 in connection with the non-payment of an annual bonus for the year 1923 by the Bombay mills. The findings of the Committee were : (1) that the mill workers had not established any enforceable claim, customary, legal, or equitable, to the annual payment of a bonus ; and (2) that the result of the working of the mill industry as a whole for the year 1923 were such as to justify the contention of the mill-owners that the profits did not admit of the payment of a bonus.

The third ad hoc Committee to be appointed in the Bombay Presidency was the Bombay Strike Enquiry Committee under the Chairmanship of Sir Charles Fawcett in connection with the general strike of the cotton mill workers in Bombay city in pursuance of the agreement arrived at between the Bombay Mill-owners' Association and the Joint Strike Committee in 1928. The report of the Committee was published in March 1929.

The next Committee to be appointed in the Bombay Presidency was a Court of Enquiry appointed under the Trade Disputes Act in connection with the general strike of cotton mill workers in Bombay city of 1929. The Pearson Court of Enquiry, as it is known, came to the conclusion that the whole of the blame for the calling and continuation of the strike rested with the Bombay Girni Kamgar Union. The Report was published in September and in consequence the Union immediately called off the strike.

Bengal

Several special Committees were appointed by the Government of Bengal during the years 1920-21.

(i) As a result of a strike of taxi-drivers and professional drivers of private cars in Calcutta, Government appointed a Committee of Enquiry into the existing licensing regulations and the control of taxicabs generally. The strike ceased as a

result of the institution of the inquiry. The Committee made a number of proposals for amendments in the existing regulations which were accepted by the Government and brought into effect in 1921.

(ii) As a result of a strike of drivers and conductors of Calcutta and Howrah Tramways which lasted for about a month, Government appointed a Committee of Enquiry. The workers resumed work on the condition that the Calcutta Tramway Company would investigate their grievances and announce their decision within a week and that if men were dissatisfied with the Company's decision, Government would appoint a Committee of Enquiry. Majority of the recommendations of the Committee were acceptable to the Company and the representatives of workers. But some of the Directors of the Company did not accept the terms with the result that another strike of a much more protracted character broke out. The workers, however, failed to hold their own and resumed the work unconditionally.

(iii) A Special Conciliation Board was constituted by the Government, during a strike on the light railway of Messrs. Martin and Company, at the joint request of the employers and the employees concerned. The Board succeeded in effecting compromise on most of the points raised by the workers.

(iv) The Bengal Legislative Council passed a resolution in March 1921, to the effect that the Government should appoint a Committee to enquire into the causes of the prevailing industrial unrest and suggest remedies thereof. The Committee found that "many of the strikes which have occurred during the last nine months could have been prevented or could have been settled more speedily if a more cordial spirit of co-operation had prevailed and if some machinery had existed for bringing parties together immediately the differences occurred and before it had time to develop into a serious dispute." Therefore the Committee recommended: the establishment of Joint Work Committees in industrial concerns similar to those proposed by the Whitley Committee in Great Britain; because the Committee thought that the idea of 'panchayat' as an agency for settling the social and economical affairs is familiar in India, and a Joint Works Committee organized on proper lines would supply a 'panchayat' for regulating industrial affairs, so far as they concern the workers. Non-intervention of Government in private industrial disputes which should be settled by voluntary conciliation; the constitution by Government of a Conciliation Panel to deal with the disputes,

in public utility services; and the appointment by the Government of Special Conciliation bodies in the case of private industrial disputes, if both parties desired outside intervention. As a result of the recommendations of the Committee, a representative conciliation panel was constituted, leading public bodies being asked to recommend persons to serve on it. The panel was reconstituted every year till 1929, when it was superseded by the Trade Disputes Act. The panel was intended to deal only with disputes affecting public utility services in Calcutta and its neighbourhood. In the settlement of ordinary labour disputes not directly affecting the public, the Committee opined that the Government should not ordinarily intervene. But if both the parties express a desire that their differences should be investigated by an impartial authority, the Governor in Council should be prepared to establish a conciliation board to deal with the matter, or to take such other action as might be suitable in the circumstances of the case.

Something needs be said about the circumstances which led to the passing of the Indian Trade Disputes Act. The outbreak of industrial unrest on a large scale as an aftermath of the Great War led the Government of India to explore the possibility of providing some machinery for the settlement of industrial disputes. Enquiries were instituted in this connection in 1920, which revealed that in the peculiar industrial conditions existing then no legislative provisions for preventing industrial disputes could be effective. The increasing interest of the awakening demos in industrial relations and the growth of enlightened public opinion coupled with greater organisation among industrial workers helped to pave the path for protective legislation. Therefore in 1924 the Government of India prepared a draft Bill for enabling the investigation and settlement of trade disputes and circulated it with a view to ascertain the public opinion and the views of those taking special interest on the subject. The results of the inquiries and the experience gathered thereafter conclusively proved the desirability of legislative provision for the prevention and settlement of industrial disputes. Hence the Indian Disputes Act was passed in 1929.

The main part of the Act falls into three parts. Clauses 3 to 14 provide for the establishment of tribunals for the investigation or settlement of trade disputes. This part of the Act is based generally on the British Industrial Courts Act of 1919. The main difference, however, is that, whereas the British Act sets up a

Standing Industrial Court, the conciliation Courts which the present Act provides for are to be appointed ad hoc like the Courts of Inquiry in order to deal with particular disputes. (Re: Statement of Objects and Reasons). In justification of the measure the Report of the Select Committee says: "we have considered various proposals designed to lay upon the Government a definite obligation to convene a Court of Enquiry or a Board of Conciliation in cases where one of the parties so required. We think, however, that, unless both parties are agreed in desiring a reference it would be useless to fetter the discretion of the Government as to the time at which the matter is ripe for action under this clause. At the same time, we think that no option should be left to the Government to refuse to appoint a Court or Board where the Government is assured that both parties are agreed as to the necessity of a reference as well as to the form which it should take."

A Board of Conciliation may consist of (1) One independent person or (2) One Chairman who shall be an independent person and two or four other members. In the latter case the members may be either independent persons or may be persons appointed in equal numbers to represent the parties to the dispute at their recommendation. If, however, any party fails to make the necessary recommendation within the prescribed time, the appointing authority shall select and appoint such persons as it thinks fit to represent that party. The object of Courts of Inquiry is to investigate and report on such questions connected with dispute as may be referred to them. If after a dispute has been referred to a Board, parties to the dispute arrive at a settlement, the Board shall drop a memorandum of the settlement signed by the parties and send a report of the settlement, together with the memorandum, to the authority by which it was appointed. If they fail to arrive at a settlement, the Board shall send a full report, setting forth the facts and its findings thereon together with the recommendations for the determination of the dispute, to the authority by which it was appointed. Neither party is under any obligation to accept the findings of the Court or the advice of the Board, and in cases where the dispute is not brought to an end during the deliberations of the tribunal that has been appointed, reliance is placed on the force of public opinion which will be enabled by the publication of the report of the tribunal to arrive at just conclusions on the merits of the dispute (vide, Statement of Objects and Reasons). The present Act, like the English Act, provides that every report of a Court or Board, whether final or interim, must be published.

The second part of the Act consists of Clause 15 which relates to public utility services. According to the definition given in the Act, 'Public Utility Service' means and comprises any railway service which has been notified by the Governor General in Council as such; any postal, telegraph or telephone service; any undertaking which supplies light or water to the public; any system of public conservancy or sanitation. Strike without previous notice by workers employed on monthly wages in public utility services is penalised. This is a very important and wholesome provision. The clause is based on the principle that persons whose work is vital to the welfare of the community generally should not be permitted to go on strike before sufficient time has been given to examine the merits of their grievances and to explore the possibilities of arriving at a settlement. Lock-outs by the employers are like-wise subject to penalty.

Third part of the Act consists of provisions relating to illegal strikes and lock-outs. It is based on the British Trade Disputes and Trade Unions Act 1927. Any strike or lock-out to be illegal must have other objects than the mere furtherance of a trade dispute within the industry to which the strikers or employers belong and it must be designed to coerce Government either directly or by inflicting severe general and prolonged hardships on the community. The application of money in direct furtherance or support of any such illegal strike or lock-out is also illegal. Further, such illegal strikes or lock-outs are deprived of the protection granted to them by the Indian Trade Unions Act.

Working of the Act

The Act has been on the Statute Book for more than six years, but it has been used only on four occasions; once by the Government of Bombay when they appointed a Court of Enquiry in 1929 to enquire into the general strike in cotton mills in Bombay city, twice by the Government of India who appointed a Board of Conciliation in 1930 in connection with a dispute in the B. B. & C. I. Railway, and another Court of Enquiry in 1931 to enquire into and report on the grievances of the workers retrenched on the Indian railways; and once by the Government of Burma.

Labour Commission recommended that the possibility of establishing permanent Courts in place of ad hoc tribunals under the Act should be examined and that the question of providing means for the impartial examination of disputes in public utility services should be considered. Further, the Commission recommended that Section 13 of the Trade Disputes Act should be amended so as to provide that no prosecution or suit shall be

maintainable on account of any breach of the Section or any damage caused thereby, except with the previous sanction of the Government which appointed the tribunal. This last recommendation was accepted by the Government and the Act was accordingly modified in 1932.

The Government of India issued a circular letter in May 1933 to Provincial Governments inviting their opinions as to whether the Trade Disputes Act, 1929, should be converted into a permanent measure, and what amendments, if any, should be made in the Act. Opinions were also specifically invited on the following five questions: whether any Statutory provision should be made in the Act for the appointment of Conciliation Officers; whether a permanent Industrial Court on the lines of the British Industrial Court should be established in each province; whether strikes or lock-outs should be prohibited during the pendency of a Court of Enquiry or a Board of Conciliation; whether awards of Board of Conciliation should be made binding on both employers and employees; and whether picketing either by itself or when it is resorted to while a strike has been referred to a Court or Board should be made illegal.

It is a relief to note that the Government of India have converted the Trade Disputes Act into a permanent measure. Again, the recommendation of the Royal Commission that every Provincial Government should have an officer or officers whose duty it would be to undertake the work of conciliation and to bring the parties privately to agreement has been accepted and the Commissioner of Labour in Madras, the Director of Industries in the Punjab, the Director of Statistics and Labour Commissioner in Burma and the Deputy Commissioner and the Director of Industries in the Central Provinces are entrusted with powers as Conciliation Officers.

The Act is modelled on the lines of the English Act. When put on the Statute Book, it was thought to be essentially an experimental measure and was to remain in force for a period of five years. The Act embodies some of the recognized modes of settling industrial disputes.

From the foregoing it will be seen that notwithstanding its voluntary nature, once a Court or Board is appointed, it is given all the powers of a law court under the Civil Procedure Code and therefore the parties must submit their disputes to the jurisdiction of the Court of Enquiry or the Board of Conciliation. But there is no legal compulsion to adopt any finding of the Court. The enforcement of these findings is left to

the pressure that a well informed public opinion can exert, after an impartial inquiry. The most striking feature of the Indian Act is that the Board of Conciliation has been given a legal procedure. Per contra, the general consensus of public opinion is that Boards of Conciliation work most successfully when least formal and particularly when least legalistic in their attitude and procedure. Even the representation of any party by a member of the legal profession is prohibited in some countries. In Canada, the Board has power to disallow the parties to appear with a counsel or solicitor. In India, any party shall be entitled to be represented before the Court or Board by a legal practitioner.

There is a section of public opinion in this country pressing for the introduction of the principle of compulsion, either by making obligatory the reference of disputes to arbitration or by the enforcement of the awards of the tribunals. As against this, it is argued that the principle of compulsion in referring disputes to arbitration is fraught with grave dangers¹. The intervention of the external authority is thought to be undesirable and efforts should be made to develop the spirit of mutual understanding. This is what we learn from the experience of other countries adverted to above. "We believe," says the Labour Commission, "that the effect on industries would be disastrous if there was a general tendency to look to some external authority to preserve industrial peace and to discourage settlement by the industry²." A settlement by arbitration will stir up more irritation and bad feeling than a settlement by mutual agreement on a Conciliation Board. Consequently, resort to it should never be had except when it is absolutely necessary. Even when there is arbitration agreement in reserve, it is well to enforce delay in the hope that greater coolness of an adjourned discussion may bring about a settlement. The British Industrial Courts Act rightly emphasises that the prevention and settlement of disputes must be essentially voluntary, both in the letter and spirit. This principle can be usefully incorporated in the Indian legislation. Whitley Commission has rightly remarked that "India has tried to copy the less valuable part of the machinery employed in Great Britain whilst ignoring the most valuable part. There, less reliance is placed on ad hoc public enquiries of the kind contemplated by the Indian Trade Disputes Act than in the efforts of Conciliation Officers and others to bring the parties privately to agreement." Further, the Indian Trade Disputes Act makes no specific provision for settlement by arbitration.

1. *Vide*, Report of the Labour Commission, p. 345.

2. *Ibid*.

Granted that resort to arbitration should not be encouraged, it cannot be gainsaid that provision should be made for resort to it as the last resource. In the absence of such a provision, differences may entail strikes and lock-outs, and, even if a *modus vivendi* upon the immediate issue be found, the controversy is apt to give a rude shock to the established conciliatory system. If, however, the means of securing an arbitrator are provided beforehand, they provide an invaluable safeguard to both the parties against a possible future rupture due to passion and excitement. The *vis inertiae* is thrown on the side of peace, since there is no escape from an amicable solution except the strong step of withdrawal from the Board. Thus, from what has been adverted to above it will be seen that India has tried to copy less valuable part of the machinery employed in Great Britain whilst ignoring the most valuable part. In England, less reliance is placed on *ad hoc* public enquiries of the kind contemplated by the Indian Trade Disputes Act than in the efforts of conciliation officers and others to bring the parties privately to an agreement.

Thus, the legislative authority in India seems to be vacillating between conciliation and arbitration. The attitude of the Government of India does not guarantee the evolution of any recognized system of maintaining industrial peace. Other countries have chosen their methods. Either they have entirely resorted to conciliation or stuck to arbitration as their remedy. In some States both the methods are found working. In India the Government has adopted a peculiar attitude. The attention has been concentrated largely on the final stages of disputes. As a rule, committees and tribunals have been set up only when disputes had attained considerable magnitude, and when a strike was either imminent or in being. Government takes up the attitude of a passive spectator in the earlier stages of the disputes and intervenes when the situation reaches the climax. Then it becomes difficult for either party to retreat from the bellicose position and the settlement becomes most difficult. *Per contra*, the Industrial Courts Act provides: "Any Trade Dispute as defined by this Act, whether existing or apprehended, may be reported to the Minister by or on behalf of either of the parties to the dispute, and the Minister shall thereupon take the matter into his consideration and take such steps as seem to him expedient for promoting a settlement thereof." Thus the British Act provides for prompt action being taken, which Indian Act has failed to incorporate. The policy pursued by the Ministry of Labour is to avoid unnecessary intervention and to encourage the parties to reach a settlement themselves and in this respect they have achieved commendable

success. The differences are, in the main, settled long before relations become strained.

From the foregoing facts it will be seen that the important question for decision is whether it is better to rest content with a simple agreement to employ defined conciliatory processes when a conflict is threatened or set up and maintain permanently in being some regularly constituted organ of negotiation. It has been accepted that in the absence of some permanent machinery, it will be necessary to appoint negotiators at a moment of heated controversy, and the attempt to do this may not only involve delay but also afford opportunity for obstruction and friction. Further, the prospects of peace would be substantially improved by the establishment of permanent Boards containing representatives of employers and employed meeting together regularly. When thus brought together, the representatives of employers and employed will come to regard themselves more as partners and less as hostile bargainers, and consequently, when differences between them do arise, not only will the general trend of discussion be more amicable but also both sides will be imbued with a feeling that extreme action must at all cost be avoided lest it should destroy the very institution which had rendered invaluable aid in furthering their common interest. The Royal Commission on Labour stressed the importance of permanent Courts in mitigating industrial strife but found it unsuitable to Indian conditions. "A permanent tribunal would have two advantages. In the first place, its existence would eliminate the delay inevitable in constituting the tribunals under the present scheme. By experience it would acquire intimacy with industrial questions and facility in dealing with them. On the other hand, it is important that the members of a tribunal should command the confidence of the parties and there are frequently persons who, though eminently qualified to assist in settling one dispute, might be of little service in connection with another. Nor would it be easy to find non-officials who are prepared to serve on any tribunal, when called." The difficulties pointed out by the Commission, though real, are not insuperable and if the Government so seek the co-operation of non-official agencies like Universities and other public bodies, the services of the right sort of people can be easily had when needed. What is, therefore, suggested is the establishment of permanent Boards, having adequate labour representation.

As regards the constitution of the Board, everything which might engender irritation should be excluded. The procedure should

be simple and lawyers should not be admitted before the Board. This will tend to reduce to a minimum the opposition between parties. Further, the conciliatory, as distinguished from the litigious, character of negotiations should always be kept in view. A second inference is that the Board should not be allowed to pronounce upon any matter by the vote of a bare majority. The decision by unanimous agreement should be the rule. Lastly, the policy of deliberation in camera which is usual in England, may be expected to conduce better both to frankness in discussion itself and also to uncomplaining acceptance of the decision reached.

Further, it has been admitted that while the Indian Act restricts the power of workers in public utility services to coerce their employers, it gives in return no assurance whether their grievances will receive an impartial hearing. Therefore, to relieve the workers of this anomalous situation the Commission has recommended that provision should be made for an impartial investigation of the industrial disputes.

Before we close, however, mention should be made of a very important measure which has recently been passed by the Bombay Legislative Council making provision for the settlement of trade disputes by conciliation. In this respect, Bombay Government has given a lead to other Provincial Governments in introducing progressive factory legislation with a view to give more adequate protection to the industrial workers. The Bombay Trades Disputes Conciliation Act, 1934, therefore has filled in a much needed gap in the factory legislation. From the statement of Objects and Reasons of the Bill it is evident that the Government of Bombay had a very laudible aim "of preventing or at any rate reducing strikes as far as possible in the future", in initiating this measure.

The Act provides for the appointment of an officer called the Labour Officer to watch the interests of labour and to represent their grievances before the employers. Further, this Officer will act as the delegate of the workers in case they fail to appoint delegates when conciliation proceedings are started. In fact, the Labour Officer is vested with wide powers. "For the purpose of exercising such power and performing such duties the Labour Officer may enter any place used for the purpose of any trade or industry to which this Act applies and shall be entitled to instruct and call for documents in the possession of any employer or workman as the Labour Officer deems necessary." In short, he will try and establish contact between the employers and the employed, the lack of which has been responsible for so much financial loss

to the workers and dislocation to the industry. The success of the measure, therefore, will very largely depend upon the personality of the Labour Officer and the tact and sympathy with which he will deal with the parties to the dispute.

Another important part of the Bill deals with the conciliation machinery. The duty of the conciliator is to endeavour to bring about the settlement of the disputes and, for this purpose he is required to inquire into the dispute and do all such things that he thinks fit for the purpose of inducing the parties to come to a fair and amicable settlement thereof. He is also empowered to adjourn the conciliation proceedings if he thinks necessary to enable the parties to agree to the terms of a settlement. The Commissioner of Labour is to be an *ex-officio* Chief Conciliator.

As regards the procedure it is laid down that if any trade dispute exists or is apprehended, (a) either or both parties to the dispute may apply, whether separately or conjointly, or (b) the Labour Officer may make a report to the conciliator for a settlement of the dispute. The conciliator, on receipt of such an application or report, if he is satisfied that a trade dispute exists or is apprehended, may cause notice to be given to the parties to the dispute to appear before him at such time and place as may be specified in the notice. The parties should thereafter appoint their delegates. Ordinarily the number of delegates appointed by a party to a trade dispute will not exceed three. The maximum number of delegates to be sent by one party is fixed at 12. The Labour Officer can also be a delegate of the workers. When labourers fail to appoint delegates, the Labour Officer ipso facto becomes their delegate. Penalties have been provided for those who attempt to thwart the conciliation proceedings by instigating others not to take part in such proceedings. Picketing against a conciliation proceeding has been made a penal offence.

From what has been portrayed in the foregoing paragraphs it can be easily said that the success of the Act will be largely conditioned by the personality and attitude of the Labour Officer. The provisions of the Act set a new precedent, unwarranted by the legislation of any other industrialised country. This is due to the peculiar atmosphere of suspicion and distrust with which the Act has been conceived and nurtured. Prophecies as to the future of the measure are really very dangerous because the Act has just been put on the Statute book. The Act should, however, be given a fair chance in an atmosphere of co-operation and good will, for it is only then that its limitations can be clearly visualised.

From the foregoing comparative study it will be seen that these national legislative measures are the expression of a desire for industrial peace, and a peace based on justice. If they have not yet solved the practical industrial problem they point the way by which solution may be found. The failure to achieve the desired objective may be attributed to the defects in the constitution of the machinery. These will disappear in the light of practical experience. Improvement in the organizations of the employers and employed and the growth of better temper and greater harmony between the employers and the workers will substantially add to the success of the measures. A very large number of employers have not realised the importance of the sympathetic management of labour. Until that is accepted as sound economics, industrial harmony will remain an ideal difficult to achieve. Co-operation is a vital essential for the reconstruction of industrial relations, but so long as the want of sympathy and justice continues to feed the disputants, co-operation will never emerge as an integrating force in industry. No matter what the machinery employed, the disputing parties will imbibe the spirit of mutual agreement once they come to know and believe that matters of industrial controversy will be considered and adjusted on principles of justice and equity.

RAMSWARUP D. TIWARI

THE UNCONSCIOUS THROUGH THE AGES.

‘We have always to remember that the whole art of living lies in a fine balance of expression and repression.¹’

—*Havelock Ellis.*

‘It would be natural to feel towards him as the sailor in the story felt towards the horse who got his foot into the stirrup,—“If you’re going to get on, I must get off²”’. This is how. William James surmises, Wundt and Helmholtz might have reverted to their rationalism rather than sticking to their unconsciousism on the birth of the omnipotent unconscious of Eduard von Hartmann. Recently the advocates of the New Psychology seem to be courting similar treatment at the hands of the academic psychologists. They claim to have revolutionised Psychology, but in what way one fails to understand. They have fondled the concept of the unconscious so scandalously that to-day to define the unconscious is extremely difficult, to define it satisfactorily is well nigh impossible. If this be the revolution, then undoubtedly there has been one. But in any other sense, from the point of view of the fundamental tenets of scientific psychology, the claim of the analytic school remains a dubious one as yet. Indeed, one is required to be within the very fold of these New Psychologists to challenge the prophecy of James Ward who observes: ‘There is a psychology which arrogates to itself the title of “new”. New it undoubtedly is, and there are signs that in its present form it will not long survive As a *method* in the hands of psychologists it has done some good: as a pretended science in the hands of tyros whose psychological training has not even begun, it has done infinite harm.³’ But, whatever be its future, to-day it is living, and to speculate over its fate by judicial interpretation would not be an unhealthy exercise for a disinterested student of Psychology.

1. Havelock Ellis, *Psychology of Sex*, London, 1933, p. 222.

2. William James, *Principles of Psychology*, New York, 1890, Vol. I, p. 169.

3. *Psychological Principles*, Cambridge, 1918, p. vii. From 1918 to 1935 the situation has not changed much. The following testimony from a psychologist who is also a Freudian is to the point: ‘The trouble with psycho-analysis at present is that there is too much of the art about it, and too little of the scientific method that can be applied in experimentally controlled and repeated observations’ (Flugel, *A Hundred Years of Psychology*, Duckworth, 1933, p. 297).

Popular mind is unscientific enough to associate an article with its trademark, so much so that it brings the same outlook to bear upon even the intellectual movements. The life of Science, however, must be counted in centuries; and it is no wonder if the storm raised by the New Psychology lasts until its claims finally take root or lose the ground. The issue is quite vast and a very significant one too. To examine it in its entirety is beyond the scope of this essay which is only an attempt to understand how far and in what sense the New Psychology can exclusively claim the discovery of the unconscious as its patent property. To be precise, this needs more elaboration. But before that a few other points must be mentioned. These are:—

- I. Assumptions and Limitations;
- II. The Known Types of Unconscious Mental Activity;
- III. Outlines of the New Psychology.

I shall take up these points severally.

I. ASSUMPTIONS AND LIMITATIONS.

(a) ASSUMPTIONS.

The question 'Does mind exist?' with its allied riddles falls within the province of the philosophy of mind rather than of Psychology. The psychologist needs take no pains to prove the absurdity or efficacy of the Body-Mind relation. That he should feel interested in such problems which have a bearing on the very field of his investigations is quite natural, but this interest to him, as a psychologist, should be secondary. Mind exists: that therefore is our first axiomatic assumption; and secondly, that this mind forms an alliance with body, making experience possible—experience which brings about the fusion of the so called subjective and objective sides of the life of an individual. What we are directly interested in are the various views about the contents of mind¹ (mainly in respect of that aspect of it which is dubbed the 'Unconscious' by the New Psychologists) which have been entertained by different thinkers at different stages in the history of Psychology.²

Here a linguistic difficulty which is unquestionably serious deserves explicit notice. Language is indeed deficient for a faultless and adequate expression of the products of conceptual process. It is, for instance, impossible to avoid terms like 'mind influencing body' or 'mental factors' etc. The only way to overcome these

1. This term is not to be confused with the 'Content of consciousness' of the 'Mind-Stuff' theory.

2. Reference will be made to important persons and events only.

inherent deficiencies of language, especially in respect of its spatial and temporal associations, is again the exercise of the conceptual activity itself.¹

(b) LIMITATIONS.

The enquiry will be limited to the Western, or rather the European, thought within the period marked by the beginnings of psychology among the ancient Greeks on the one side and the dawn of Psycho-Analysis on the other.

The monograph is first a history and then a critique. Mainly it is historical in character but the history aimed at is not merely a mechanical chronicle: no true history can be that. Critical valuations, therefore, would be indulged in, but 'when' and 'how far' is to be determined by the specific needs of the historical trend. A detailed examination, therefore, of the claims and achievements of the psycho-analytic school will not be undertaken, though such a passing review is necessary to complete the task.

II. THE KNOWN TYPES OF UNCONSCIOUS MENTAL ACTIVITY².

(a) The Psychological Unconscious :

- (i) The Innate Unconscious,
- (ii) The Acquired Unconscious,
- (iii) The Freudian Unconscious.

(b) The Metaphysical Unconscious.

(a) THE PSYCHOLOGICAL UNCONSCIOUS :

(i) *The Innate Unconscious.*

Psycho-analysts start with heredity as the irreducible minimum in the mental constitution. But the way they argue minimises

1. Note the very attempt to put the difficulty into words is foiled by words like 'activity', 'process' etc., which remotely imply something with which we do not wish to associate our *pure* conception of Mind.
2. No claim to philosophical precision is advanced regarding the terminology here employed, viz., the qualifying terms 'Innate', 'Acquired', etc. Mind, by its very nature, can neither be made to fit into a compartmental system, nor can its aspects be thought of as mutually exclusive. I am not anticipating at this stage the principle of continuity in the functioning of mental apparatus. I only say that both the division and the terminology are employed to facilitate the treatment of the subject. Further in reply to a possible objection, viz., that the very issue raised here is irrelevant, two considerations may be put forward: first, that the history we aim at should be as comprehensive as possible within the limits we have set to ourselves; and secondly, that the examination of the New Psychology which will close the essay should be fair and adequate.

the importance of heredity¹. Environment comes to play the main rôle, and, further, the constructive work (if I may describe the moulding of the mind in these terms) to be wrought by the Environment is hedged within a strict time-limit. It may start with the moment of conception but cannot continue beyond the early period in the development of the individual, the limit generally suggested being the first five or six years of childhood.² The psycho-analysts thus place a limited value on what has been called the Innate Unconscious. Men like Henri Bergson³ and Samuel Butler⁴, on the other hand, ascribe to this mental inheritance a preponderant share in the product of mental activity. For others like Lancelot Hogben, heredity and environment are almost equiponderant.⁵ For our purposes it would suffice to note that by the Innate Unconscious is to be understood those inherited mental capabilities which form the foundation of the psychic life of the individual.

(ii) *The Acquired Unconscious.*

This is what is denoted by the concept of the unconscious, or rather subconscious⁶, of the traditional or even the present day general psychology. To be more precise, we are to understand by this term those deeper layers of mind which house the traces left during the process of acquiring knowledge⁷. In the language of Graham Wallas, it would be the residue of 'nurture' after excluding that part of it which is designated 'social heritage'⁸. Except for certain minor considerations, McDougall's 'mental structure', or Scout's 'mental dispositions', can be brought under this category.

(iii) *The Freudian Unconscious.*

In the Freudian terminology we have to distinguish mainly

1. This view is very likely to be seriously challenged on the strength of that pernicious and much misunderstood hypothesis of the (Edipus complex advanced by Freud and his school.
2. It needs to be noted here that this is one of the factors which makes the psycho-analysts determinists.
3. *Matter and Memory*, London, 1913.
4. *Unconscious Memory*, London, 1920 Ed.
5. *Nature and Nurture*. Hogben is not prepared to take up as yet a fine position in this respect.
6. Academic Psychology does not make any finer distinction between the two.
7. The term 'knowledge' is to be understood not in the restricted sense of being the product of the activity of the faculty of cognition alone, were it ever possible, but in its broadest sense.
8. Wallas, *Our Social Heritage*, London, 1921, p. 16.

between three types of mental activity : first, the 'perception-consciousness', i.e., the conscious activity of the general psychology¹ ; secondly, the 'preconsciousness,' i.e., the 'subconscious', or 'unconscious' of the general psychology ; thirdly, 'the unconscious'. For the Freudian concept of the unconscious, I refrain from giving any corresponding term from the academic psychology, though I could have said that it approaches, for instance, the 'unconscious mental states' of Stout.² But to hazard guesses at this stage would be detrimental to the whole discussion. Here we are trying only to understand what it is, may be in its mystical form, from the point of view of Freud himself, and I will put it in his own words : 'The term *unconscious*, which was used in the truly descriptive sense before, now comes to imply something more. It designates not only latent ideas in general, but especially ideas with certain dynamic character, ideas keeping apart from consciousness in spite of their intensity and activity'.³ Freudian unconscious is '*active and unconscious*' at the same time.⁴

(b) THE METAPHYSICAL UNCONSCIOUS.

By this term we understand the concept of the unconscious not as advocated from the psychological platform to serve as an interpretation of psychological phenomena, but as offering an explanation of the mystery behind the riddle of the Universe. Hartmann's 'Philosophy of the Unconscious,' or Leibnitz's 'Monadology' based as it is on the principle of continuity and the doctrine of pre-established harmony, are mainly attempts of this kind, though no doubt they have their respective psychological sides. In this connection, it would not be impertinent to remark that the distinction made as 'Philosophical and Psychological'⁵ with regard to 'unconscious' is better called 'Metaphysical and Psychological' in the interests of both lucidity and precision.

III. OUTLINES OF THE NEW PSYCHOLOGY.⁶

The various aspects of the New Psychology cannot be taken up for discussion here. I shall concentrate only on the following :

1. The correspondence is shown to give an approximate idea of the concept in the language of general or 'academic' psychology. They are not synonyms.
2. See Stout, *A Manual of Psychology*, 4th Ed., London 1929, pp. 27-29.
3. Freud, *Collected papers*, Vol. IV, London, 1925, p. 25.
4. *Ibid*, p. 24.
5. *Encyclopædia Britannica*, 14th Edition, Vol. 24.
6. As I have already suggested, the term 'New Psychology' would mean, for our purposes, mainly the Psycho-Analytic School of Freud. A passing notice of Freud's dissenters will be taken later.

- (a) Technique of Psycho-Analysis ;
- (b) Psycho-Analytic Theory ;
- (c) Structure of the Freudian Mind.

(a) TECHNIQUE OF PSYCHO-ANALYSIS.

Only two important features will be considered, viz., (1) Transference, and (2) Resistance.

(1) *Transference.*

The 'Free association' method ranks among one of Freud's outstanding discoveries. It was this 'talking out' process that dissatisfied Breuer but which enticed Freud and enabled him to lay the foundations of his theory. This method consists in getting the patient gradually to transfer his private self to the analyst, thereby establishing free communication between the two. It is the process by which the subject allows a free play to his libido, or sex energy, in a sort of personal—it can even be called erotic—relationship with the analyst. For effective cure in the hands of Freud and his disciples, this peculiar relationship must come about during the treatment and must not continue afterwards.¹

(2) *Resistance.*

Transference aims at getting over the usual 'resistance', or the tendency to conceal one's privacy, that is so natural even with normal minds. It is with reference to this that the psycho-analyst speaks of winning over the subject.

The importance which Freud attaches to these two factors comes out well in the following remark :

'The psycho-analytic theory endeavours to explain two experiences, which result in a striking and unexpected manner during the attempt to trace back the morbid symptoms of a neurotic to their source in his life-history ; viz., the facts of transference and of resistance'.²

(b) THE PSYCHO-ANALYTIC THEORY.

At the outset it should be realised that Freud's theory has been undergoing constant changes. There is hardly a single Freudian

1. 'The word "transference" is also used in Freudian doctrine to designate the shifting of erotic feelings from one object or person to another ; for that process Freud prefers the word "displacement". He confines "transference" to the physician-patient relation' (Jastrow, *The House that Freud Built*, London, 1933, p. 210). Freud calls it also transference of accent': see his '*New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 32.
2. Freud's *The History of the Psycho-Analytic Movement*, quoted by Woodworth : *Contemporary Schools of psychology*, London, 1931, p. 148.

concept that has not been subjected to modification in some way or other. No doubt scientific method is essentially a method of trial and error, but in the hands of Freud it has played such a havoc that now psychology seems to have been fed up with its intolerable shocks. A sketch of the theory follows.

'Freud's general idea of personality is of a conscious ego between the upper and nether millstones of the super-ego and the repressed libido'.¹ The terms ego, super-ego, etc. have already been explained. The repressed² libido is nothing but the 'unconscious' which also contains the repressive forces. This is a revised edition of Freudian views. Once the conscious individuality or the ego itself served for Freud as the censor, but now he has vacated the office and the burden falls on the Id, a master and a slave rolled into one.

Now we have to explain the principles that hold together all these fundamentals of the Freudian Psychology. These are: first, the Pleasure-Pain ('Lust-Unlust') principle, or simply the Pleasure Principle as it is called; and secondly, the Reality Principle. These two can be said to characterise the sex-instincts and the ego-instincts respectively. In adopting the Pleasure Principle Freud has accepted automatically the psychological hedonism along with its inherent fallacies. The end of all human action is happiness or more correctly pleasure. But there is again a change. Says McDougall: 'In his recent work, "Beyond the Pleasure Principle", he has revoked this error and recognised the hormic principle as more fundamental and primary than the pleasure principle; thus showing once more his remarkable power of continually developing and rectifying his views.'³ Reality Principle is based on the tendency of mind to modify the demands of the pleasure instincts in accordance with the needs of the actualities. It is the special attribute of the ego. It is the principle on which the ego acts in meeting its environment, curbing the demands of the pleasure principle whenever and wherever necessary. The super-ego acts as the taskmaster in this Freudian trinity.

(c) STRUCTURE OF THE FREUDIAN MIND.

The main features of the structure of the Freudian mind have already come out, though in a scattered way, during the

1. William Brown, *Mind and Personality*, London 1926, p. 186.
2. The distinction of far reaching importance between 'repression' and 'suppression' made by Rivers does not, as yet, find a suitable place in the Freudian thought.
3. *An outline of Abnormal Psychology*, London, 1926, p. 20.

course of the foregoing discussion. It is however, better to have the whole structure in a compact form. It would suffice to know what Freud means by Id, Ego and Super-ego. 'Id' is the Freudian Unconscious which has already been mentioned. Ego is a formation out of the Id brought about during the constant relation of the individual to his environment. Thus it is both conscious or unconscious: conscious of the environment to which the individual reacts, and unconscious in so far as it proves, time and again, implicitly or explicitly, that it is almost organically related to the Id. Ego then, is the 'pre-conscious' that has 'perceptual consciousness' of the environment which causes pain or pleasure according to the nature of the 'Unconscious' or Id, which supports it, and according to the demands of the super-ego which rules it. 'The ego tries to mediate between the world and the Id, to make the Id comply with the world's demands and, by means of muscular activity, to accommodate the world to the Id's desires.'¹ It is the super-ego which serves as a vehicle, for a good many of these Id's desires; the super-ego may be called a secondary formation if the Id is understood to be the primary one. But the super-ego is not all 'Id'; it is also to some extent a modification of the ego, a modification that dominates it. The super-ego, in Freud's language is 'something which enjoys certain independence, pursues its own ends, and is independent of the ego as regards the energy at its disposal.'² It 'has the ego at its mercy and applies the most severe moral standards to it; indeed it represents the whole demands of morality, and we see all at once that our moral sense of guilt is the expression of tension between the ego and the super-ego.'³ In 'the formation of the super-ego' lies 'the origin of conscience';⁴ but 'in postulating the existence of a super-ego', Freud says, 'I have been describing a genuine structural entity, and have not been merely personifying an abstraction, such as conscience.'⁵ Whatever else it is, the super-ego is undoubtedly one of the most superbly paradoxical of Freudian constructions. It will have to be taken up again for description, if not for explanation, in the concluding stages of our discussion. For the present I shall sum up the structure of the Freudian mind by giving a rough diagram representing

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1. Freud's *The Ego and the Id*, London, 1927, p. 83.
 2. Freud, *New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 82.
 3. *Ibid.*, p. 83.
 4. *Ibid.*, p. 84.
 5. *Ibid.*, p. 88.

in outline the topographical relationship of conscious and unconscious ; Id, Ego and Super-ego.¹

The Freudian Mind.

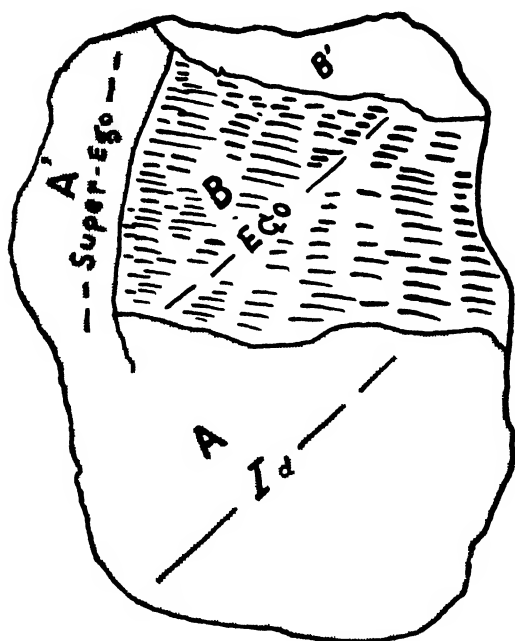


Fig. 1.

The diagram is clear so far as it goes.

"A" stands for the 'Unconscious' proper, or the 'Id.'

"A'" stands for the Super-ego.

"B" stands for the Ego, or the Pre-conscious.

"B'" stands for the 'perceptual' consciousness.

1. The diagram is adopted, with slight modification, from Joseph Jastrow's *The House that Freud Built*, (p. 88). It is based on Freud's diagram in *The Ego and the Id*, and Jastrow reproduces it from Healy, Bronner, and Bowers: *The Structure and Meaning of Psycho-Analysis*. I take it from Jastrow and not direct from Jastrow's source because I have to quote his meaningful observation: 'Freud has even reduced to a diagram how the glory of man was shaped out of the void. It seems an uncouth picture of creation; it is offered merely as a memorandum aid to imaginations concretely inclined' (p. 89).

Now, I can restate the problem in more specific terms. Two points will be considered here: First, the analysis of our aim, i.e., the 'what' of our problem; and secondly, how we are going to handle the different issues brought out by the analysis, i.e., the plan of procedure.

(a) THE ANALYSIS OF OUR AIM.

(i) To go back into the history of thought in order to note whether that part of mind which we call unconscious (in all the senses already related), or the contents of which, in part or whole are qualified 'unconscious', did or did not fall within the purview of the thinkers of the past, though they might not have called it 'unconscious', or 'sub-conscious'.

(ii) To see where in the history of thought we come across the term 'unconscious' for the first time, and in what sense.

(iii) Has the notion been developing? If it has been developing, has the development been along one line or several? If the latter, to see whether all these different lines, divergent or convergent as they may be, can be traced back to the same origin, wholly or partially.

(iv) As a corollary, to note incidentally how far the distinction between philosophical, or metaphysical, and psychological unconscious is tenable on the strength of the evidence already adduced. If tenable, is the dichotomy mutually exclusive? or does it overlap? And if it overlaps to undertake the scrutiny of the common ground to be able to say whether the overlapping is the essence or the accident.

(v) To bring out clearly the contribution of Psycho-Analysis in enlightening this aspect of our mental activity from the point of view of Psychology.

(vi) To assign a place to the play of the unconscious—whatever import we may come to give to the term by this time—in the making of man.

(b) THE PLAN OF PROCEDURE.

I.—The Unconscious in its historical setting.

Two periods:—

(A) First period: Ancient:—

- (1) Protagoras (circa 480-410 B. C.),
- (2) Socrates (469-399 B. C.),
- (3) Plato (427-347 B. C.),
- (4) Aristotle (384-322 B. C.),

(B) Second period : Modern and Contemporary :—

- (a) (1) Leibnitz (1646-1716 A. D.),
- (2) Herbart (1776-1841 A. D.),
- (3) Schopenhauer (1788-1860 A. D.),
- (4) Hartmann (1842-1906 A. D.).

- (b) Samuel Butler and others including Henri Bergson and Frederic Myers.
General Considerations.

II.—Unconscious of the New Psychology.

- (a) Its Theoretical Aspects ;
- (b) Its Practical Aspects.

III.—Retrospect.

I. THE UNCONSCIOUS IN ITS HISTORICAL SETTING.

(a) THE FIRST PERIOD :

The consensus of scholarly opinion gives the credit of laying the foundations of scientific psychology to Aristotle in recognition of his work 'De Anima'. But it must be remembered that Aristotle had the distinct advantage of standing over the shoulders of a good many powerful meditators of the past, among whom must be named as the first and the foremost, Socrates¹ and Plato². True, the problem under discussion being psychological, and quite a scientific one at that, its treatment should naturally be expected to start with Aristotle, the accepted founder of scientific psychology³. But the enquiry being, in the main, historical, to neglect the prominent forerunners of Aristotle means falling an easy dupe to 'De Anima'. The shortest cut to understand and appreciate the work of a great mind is always a straight line. And to get what is precious in them for us, Socrates and Plato must be directly approached. But before that a word about Protagoras.

(1) *Protagoras* (480-410 B. C.).

Socrates and Plato do owe a debt to Protagoras as the founder of the psychological methodology. The method of Protagoras was

1. See *An Outline of Modern Knowledge*, London, 1931, Aveling's article on *Psychology*, p. 310.
2. 'It is often forgotten that Aristotle derived much of his information from Plato, and we must specially observe that he more than once takes Plato's irony too literally' (Burnet, *Early Greek Philosophy*, 2nd Ed., London, 1908, p. 420).
3. See Ward, *Psychological Principles*, Cambridge, 1918, p. 2. Also see Brett's Article *History of Psychology*, *Encyclopædia Britannica*, 14th Ed., Vol. 18, p. 707.

a subjective one applied to psychology which was empirical in character. It is this empirical psychology of Protagoras, the Protagorean relativism, that made 'man' 'the measure of all things.' This relativity comes out well when Protagoras says, 'Matter is a pure flux, it is not anything fixed and determined in itself, for it can be everything, and it is different to different ages and to the various conditions of waking and sleep'.¹ Reference to 'ages' and 'the various conditions of waking and sleep' testifies to the admirable powers of reflection of Protagoras with regard to the psychic side of man's life². His perception theory was based on two types of motion: one in the thing itself, other in the percipient organ. This motion, in both its ways, was a condition precedent for 'perception' which becomes on the very theory independent of both. It was fundamentally this principle of the subjective nature of sense-perception that established for Protagoras the identity of perception and the entire knowledge of the thing perceived. As Hegel observes: 'Reflection on consciousness came to consciousness with Protagoras',³ and thus, in a sense, it would not be beside the point to speak of him as the Descartes of Ancient Greek philosophy. Here, then, are the crude beginnings of looking at mind as the motivating and activating agency playing an important part in determining the nature of our Experience.⁴ As an historical event this discovery should prove of considerable importance to the student of even current dynamic psychology.

(2) *Socrates (469-399 B. C.)*

Socrates also mainly concentrated on method. He seems to have entertained no ambition to develop a philosophical system, or a psychological theory, of his own. 'He was neither *savant* nor wandering teacher, belonged to no school and adhered to none.'⁵ That his method alone brought him all the honour that is so

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1. Quoted by Hegel, *Greek Philosophy*, London, 1892 Ed., Vol. 1., p. 376-77. For a literary expression of this conditioning character of mind, cf. Milton :

'The Mind is its own place, and in itself
Can make a Heaven of Hell, a Hell of Heaven.'
(*Paradise Lost*, Book I.)

2. Windleband remarks: 'The germ of the doctrine of Protagoras is found in his effort to explain the ideas of the human mind *psychogenetically*' (*A History of philosophy*, London, 1914 ed., p. 71).
3. *Ibid.*, p. 377.
4. In the Protagorean sense.
5. Windleband, *A History of philosophy*, London, 1914 ed., p. 71.

deservedly his is because of its aim, viz., self-knowledge and self-development; 'know thyself' was the core of his life's mission. Socrates not only lived his philosophy but died a martyr in its cause. If we leave aside the method, we find that the main purpose of Socrates coincides with the immediate goal of the psycho-analysts.¹ It is difficult to exaggerate the intimate knowledge of human nature and mental activity essential for the work which Socrates did in those times. This is so well seen in his dialectical arguments. He boiled, as it were, the mind of the other party in such a way that a superficial observation was reduced to a logical proposition through a process of convectional currents. Reason, for Socrates, was the logical nexus upon which the whole argument revolved.

Life, however, transcends Reason at times when even the greatest have to confess their helplessness. 'Dæmon' was the explanation of Socrates for this kind of helplessness. To understand the full meaning of this 'dæmon' it must be realised that Socrates was not only a moral teacher but was also anxious, all his life, to 'know' human life and its development in their entirety. The practical side of life was his chief concern. In this light the 'dæmon' clearly appears to be something in human conduct that defied the rationale of the Socratic psychology. No doubt, Socrates thought of it as the God in man, but this God seems to be only that ever ready benefactor of philosophers—*a deus ex machina*. Here a query is possible. In this way, it may be said, a good many philosophers will have to be brought in line with Socrates. To satisfy this doubt a distinction needs notice. Socrates introduces this *deus ex machina* not as an explanatory principle to overcome an obstruction threatening to founder an ideal philosophical construction but as something to stand for the very part of the self which eludes a reasoned analysis of its nature. Socrates the reasoner had to stoop and

1. The following observations are to the point:—

- (1) 'The Freudian Ethics is a literal and concrete justification of the Socratic teaching.'

—Holt, *The Freudian wish and its place in Ethics*, London, 1915, p. 141.

- (2) 'Psycho-analytical treatment essentially consists in the attainment of the patient of fundamental self-knowledge by systematic and lengthy introspection.'

—von der Hoop (*Character and the Unconscious*, London, 1923, p. 26).

- (3) 'Know thyself is the first maxim of mental hygiene.'

—McDougall, *Energics of Man*, London, 1932, p. 304.

- (4) Also see *Outline of Modern Knowledge*, London, 1931, Flugel's article on the *Theories of Psycho-Analysis*, p. 369.

admit his inability to go ahead beyond a particular limit in the analysis, or even the understanding, of his self. Socrates' 'dæmon' then comes to be that unanalysable part of the self which wields visible influence in the explicit manifestations of the self's activity.

Unfortunately we lack adequate help from scholars to enable us to say something definite to bring out the significance of the Socratic 'dæmon' in the language of current psychology. The problem of the Unconscious, in one form or other, has received the attention of many a psychologist of our generation. But in ascribing the historical leanings of this particular aspect of the mind, the farthest limit reached seems to be Plato.¹ Three scholars, however, may be said to render a substantial help in making us feel secure on the ground of our finding. I refer to Hegel, Zeller, and Gomperz. To avoid possible distortion, I shall quote here passages from their works for being judged on their own merits.

1. (a) Describing 'the characteristic form in which this subjectivity—this implicit and deciding certainty—appears in Socrates' Hegel writes², 'Since everyone here has this personal mind which appears to him to be his mind, we see how in connection with this, we have what is known under the name of the Genius of Socrates; for it implies that now man decides in accordance with his perception and by himself. The Genius³ of Socrates is rather all the other and necessary sides of his universality, that is the individuality of mind which came to consciousness in him equally with the former.....That in Socrates we should discover what comes to pass through reflection in the form of the unconscious, makes it appear to be one exceptional matter. revealed to the individual only, and not as being what it is in truth. Thereby it certainly receives the stamp of imagination, but there is nothing more of what is visionary or superstitious to be seen in it, for it is a necessary manifestation, though Socrates did not recognise the necessity, this element being only generally before his imagination' (p. 422).

(b) 'The Genius of Socrates is thus to be taken as one actual state, and is remarkable because it is not morbid but was

1. Perhaps the vagueness of the Socratic 'dæmon' with no psychological theory to back it justifies their indifference.
2. *History of Philosophy*, London, 1892 ed. Vol. 1.
3. One of the many interpretations of Socratic 'dæmon'. It should be noted that we are not committing ourselves to Hegelian psychology. The question does not arise here.

necessarily called up through a special condition of his consciousness. For the turning point in the whole world-famed change of views constituting the principle of Socrates, is that in place of the oracle, the testimony of the mind of the individual has been brought forward and that the subject has taken upon itself to decide' (p. 425).

2. Zeller¹ is in complete agreement with Hegel regarding this forward step taken by Socrates. But he proceeds to point out 'a compensating drawback'. He observes: 'The mind when first disenthralled and placed in a position to exercise its own freedom, could not at once trust its own decisions in every case, but allowed any indefinite impulses which claimed to be divine revelations to prevail against the dictates of its own intelligence. The *Daemonium* of Socrates was not therefore Socrates himself, but a kind of oracle, his mind, but his mind only half conscious of itself' (p. 80).

And describing the 'daémon' in his own words Zeller goes on to say: 'As he watched with careful eye all that transpired within, endeavouring to let nothing escape him, he discovered a residue of feelings and impulses, which could not be explained from what he knew of his inner life. This he regarded in the light of divine revelation, and believed that he enjoyed it in that particular form which goes by the name of the *Daemonium*' (p. 73).

3. Gomperz writes²: 'The statement that the daémon³ held him back whenever he felt any inclination to take active part in politics, may be taken to indicate that he was here guided by a species of instinct, a dim but truthful estimate of his own capabilities emerging from the subconscious undercurrents of psychic life' (p. 88).

All these passages go to show that Socrates did recognise in his 'daemon' what we to-day call the unconscious. That he called it 'Daemon' or the God is but the result of the social milieu in which he was brought up. It was due to what we have called the acquired unconscious. This Daemon has its source in the unconscious, or rather the extra-conscious, and is all the more powerful and determinate than the conscious individuality of Socrates; and the recognition is made by Socrates himself. Thus I suggest that it may be looked upon as the element of the unconscious in the psychology of Socrates. As far as I can understand the distinction made by Freud between the Ego, the

1. *Socrates and the Socratic Schools*, London, 1868.

2. *Greek Thinkers*, London, 1913 Ed., Vol. II.

3. In Greek in the original.

Super-ego, and the Censor, I hazard the opinion that the Socratic Dæmon comes very near to the Freudian Super-ego.

Before I take up Plato, I have to add a paranthetical remark which has reference to the whole discussion. When I say that a particular aspect of mental activity is designated 'X' by Socrates and 'Y' by Freud, and further add that in their objective reference the two expressions are almost identical in nature, what is presented is a mere 'scientific' description of facts—a description which has nothing to do with the question of the correctness of either. What is emphasised is the recognition of a particular aspect of mental activity by the thinker himself and the correspondence, if there be any, between that conception and the modern one. Take for example, the letters 'P' and 'π' of the English and the Greek alphabets respectively conveying, as they do, virtually the same phonetic value. Now if I assert that 'P' and 'π' are two letters, the one English and other Greek, almost identical in their nature inasmuch as they have the same linguistic significance, I think that my statement does not in the least imply any judgment about their respective propriety or impropriety. This confusion needs to be guarded against throughout this discussion.

One more thing. In pointing out similarities—distinctions would not create any confusion—I do not in the least suggest that Socrates, for instance, has anticipated Freud, or Freud has borrowed from Socrates. To maintain that in scientific language, substantial and specific evidence of other kind is required. And even supposing that Socrates has said something that appears to us as having a genetic relation to Freudian findings, Freud's greatness is none the less for that. Creation indeed is difficult and critics are but pigmies before creators. Our purpose, I repeat, is to understand the evolution in time of the ideas about mind with reference to one of its particular aspects, viz., the unconscious.

(3) *Plato (427-317 B.C.).*

From stimulus to response is only a step. And Socrates leads us to one who stands unparalleled in the history of philosophy for his exemplary veneration towards a worthily revered master.

The Psychology of Plato was a sort of bridge between his Metaphysics on the one hand, and Ethics on the other. Plato had already postulated the doctrine of Ideas to explain the world of Becoming. This metaphysical theory of the universe, however, was but an aspect of Plato's genius. Along with his eagerness to solve the riddles of another birth or another world, Plato was keen enough to lay his hands on the problems at hand with equal

enthusiasm. He had an ardent desire to understand and evaluate human nature in all its aspects. For this again he needed some principles, if not a theory, which would account satisfactorily, for all the variety of mental phenomena before he could come to think of the fundamental problems of life. Here the difficulty arose. As a great intellectualist Plato hankered after consistency. Consistency is lame without relevance and Plato in his attempt to incorporate the theory of Ideas in the principles he postulated to explain Mind and its working, leaves us a specimen of what may be called metaphysical psychology. But however fictitious it may appear on its theoretical side, in its applied form Plato's Psychology bears all the marks of a genius.¹ It is, as Windleband points out, 'A first attempt to understand the psychical life from within, and in accordance with its internal character and articulation'.² I have said enough to indicate that in trying to define Plato's conception of Mind we are confronted at the outset with the difficulty of understanding 'Soul' as something that is split up into parts to enable it to answer two calls in the main, viz., that of the World of Ideas and of the World of Phenomena. This feature which manifests itself in the tripartite division of the soul pervades Platonic thought in its psychological no less than its ethical aspects. Plato divides Soul into three parts, viz., (1) the rational, (2) the irrational which is further divided into (i) the spirited and (ii) the appetitive. The first part, i.e., the rational stands for pure Reason, and is the special privilege of man as against the lower creation. It is through the agency of this side of his nature that man is able to get into touch with the World of Ideas. The other part, i.e., the irrational one, with its subdivisions, brings the soul into contact with the world of sense or of Becoming. As we are concerned with only an aspect of Plato's Psychology, what has been already said about Plato's psychological reasoning will suffice. The Platonic riddles whether the entire soul, or only the pure or rational part of it, is immortal, or how far we are to take Plato literally at all so far as this tripartite division of the soul is concerned, need not detain us. To suit the present purpose, three points in Plato's teachings are singled out: first, the Doctrine of Eros (The *Symposium*); secondly the Recognition of Dreams (The *Republic*); and thirdly, the Doctrine of Reminiscence (The *Meno*).

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1. Referring to Plato's theory of Education Brett writes, 'It is the first great example of applied psychology and also presents the germs of social psychology' (*Encyclopædia Britannica*, 14th Ed., Vol. 18, p. 707).
 2. *A History of Philosophy*, London, 1914 Ed. p. 123.

(a) THE DOCTRINE OF EROS.¹

Eros is the *clin vital* of Plato's philosophy of Life. The significance of this doctrine has been elaborated by Plato in that splendid piece of artistic creation,—the *Symposium*. Eros manifests itself in all the various forms of human life and even Reason as an aspect of the human soul is under the influence of this fundamental drive. Viewed in its proper perspective, the *Symposium* is not altogether a fiction. Except for some fundamental questions which remain unexplained, but which are not peculiar to this doctrine alone, the story of *Symposium* remains pretty consistent with the general trend of the Platonic thought. Soul, prior to its birth in human form, existed disembodied and being pure Reason could be in direct contact with the World of Ideas. But once it got enchained within the bodily confines it no more remembered, by itself, the Ideas. It was enjoined to co-operate with the irrational part and its purity was polluted. It was then that some agency was necessary to revive the memory of the Ideas. Beautiful objects, for instance, are one such agency which reminds the human soul of the Idea of Beauty that ultimately becomes the goal for the virtuous. Man thus becomes a creature who has through Reason the knowledge of the Good from the beginning, but he is essentially an imperfect creature, being himself a constituent of the World of Sense, and can only hope to advance towards perfection through the symphony of all the three sides of his soul.

Eros of Plato is mainly a fundamental drive permeating all the activities of human life, but there are also other important factors characterising this impulse which stand out in their true colours only when the dialogue is read as a whole. Taken partially, we are most likely to be misled in either of the two ways: the one form is the scandalising interpretation of the much misunderstood concept of Platonic love; the other extreme is to identify the Eros of Plato with the philosophic impulse only. Both these points of view are too partial and therefore misrepresentations. True, to start with, Eros is represented as a vague and sensually inclined impulse, it is also true that the end or the ultimate goal of this Eros is to be the 'philosophic

1. I hold that if Plato is to be referred to in connection with the Freudian or the Psycho-analytic thought it is his doctrine of Eros that needs to be emphasised more than anything else. Northridge, for instance, in his *Modern Theories of the Unconscious*, (London, 1924) refers in a very passing way only to the recognition of memory and the 'appetites' as noteworthy points. See p. 1—2.

impulse'. These two are extremes. But extremities do not make a straight line, and what is of fundamental importance with regard to the Platonic Eros is the *urge* that underlies the development of this impulse from beginning to end as also the various stages of the process itself. The extraordinary differences between the respective nature of the two extremities are only superficial. Rightly understood they are not two, but only two aspects of one and the same fundamental drive. These aspects in their specific form are especially human, though the drive in a slightly different form is also found with the animal world.¹ This makes it sufficiently clear that the two ends represent a kind of series having for their common denominator the hankering after perfection in one form or other. Here, for instance, with reference to sensual love it is the craving for immortality by means of the continuation of the species, while in respect of the philosophic impulse it is the yearning of the soul to be immortal through a process of the contemplation of the Good which is also the Beautiful. I may now restate this impulse as an urge to overcome pain and conquer pleasure, to enhance the happiness of man by getting within reach of the immortality of the soul.² Having thus far explained what 'Eros' means as a platonic concept, I proceed to point out its relative importance from the point of view of the Freudian concept of Love or what is otherwise known as the Libido.

The word 'sex' in the Freudian use of the term 'libido' or sex energy has a very wide connotation. Flugel remarks: 'The terms "libido" and "sex", as used in Freud, are in fact used somewhat similarly to the "Love" of Christian tradition or the Platonic Eros, though the psycho-analytic views as to the nature and development of "sex" are far more detailed and precise'.³ The first part of Flugel's statement cannot be gainsaid but the latter cannot easily be endorsed. Nicoll has rightly pointed out the one-sidedness of the Freudian concept of libido.⁴ As I shall have occasion to show later, it is the peculiar Freudian use of the

1. It is interesting to note here the point, which I shall have occasion to refer to at a later stage, that the Freudian Super-ego is a development peculiar to man and man alone.
2. The words 'pleasure', 'pain' and 'happiness' are to be understood in the Platonic sense which differs from the Freudian.
3. *An Outline of Modern Knowledge*, London, 1931, Flugel's article on the 'Theories of Psycho-Analysis' pp. 373-74.
4. *Dream Psychology*, London, 2nd Ed., 1920, p. 77 ff. See also McDougall, *An Outline of Psychology*, London, 6th Ed., 1933, p. 431 ff. note (i); and Jastrow, *The House that Freud Built*, London, 1933, p. 48 ff.

term "libido" that is to be counted as one of the grounds on which Jung and Adler had to disagree with their leader.

The resemblance between the Platonic Eros and the Freudian Libido has a manifold significance. Both stand for that imperceptible primal urge which goads on and explains Life. It is in the Platonic conception of Eros that we have the germs of those basic principles of the psycho-analytic theory, viz., the 'Lust-Unlust' Principle and the Reality Principle, of the play of the sexual impulse, of the conflict of various desires—all these as constituting the essence of man's struggle for a condition of equilibrium, for some measure of happiness. Furthermore, it must be noted that the dream-condition and the talk about appetites that we read in the 'Republic' has a genetic connection with the influence of this 'Eros'.

(b) THE RECOGNITION OF DREAMS.

In his Introduction to Henri Bergson's 'Dreams', Slosson writes: 'Before the dawn of history mankind was engaged in the study of dreaming..... When a scholar laboriously translates a cuneiform tablet dug up from Babylonian mound where it has lain buried for five thousand years or more, the chances are that it will turn out either an astrological treatise or a dream book.'¹ Whatever it turns out to be, I am only concerned with the gist of the remark. The problem of dreams is not a new one. 'The first book', Freud himself says, 'in which the dream is treated as an object of psychology seems to be that of Aristotle'²; but further he has rightly pointed out that the investigation of the phenomenon of dreams on scientific lines has never been undertaken before him.³ The claim is perfectly justified.⁴ It is indeed true that with the dawn of Psycho-Analysis the scientific study of dreams has been brought to the front. But how far this zeal of the analytic spirit has succeeded in unravelling the mystery enwrapping the world of dreams remains yet a question for the future. The various ways of interpreting dreams, for instance, are still in the crucible as regards their respective merits. To refer only to the Freudian way, Rivers has rightly shown some of the salient drawbacks of the Freudian theory of dreams.⁵ Rivers finds reasons to disagree with Freud's

1. Henri Bergson, *Dreams*, 2nd impr., London, 1915, p. 5.
2. *The Interpretation of Dreams*, London, 1915 ed., p. 2.
3. *Ibid.*, p. 3.
4. Cf. Rivers, *Conflict and Dream*, London, 1923, p. 2. Also, Tansley, *The New Psychology*, 9th impr., London, 1924, p. 131.
5. *Conflict and Dream* is a treatise mainly devoted to the critical examination of the Freudian theory of dreams.

views on the nature of dreams as wish fulfilments, 'distortion' as a universal feature, as also the Freudian symbolism.¹ Here it is not my intention to undertake the examination of dreams as a psychological phenomenon. What I wish to show is only that Plato was aware, in very much the same way as the 'psychic-researches' of to-day, of the significance of the dream-consciousness having its abode in 'a sort of subuniverse alongside of the waking world'², or in the unconscious or extra-conscious as we may call it. In support I have only to quote a passage from the *Republic* to show how it stands from the point of view of Psycho-Analysis.

By way of preliminary considerations, however, a few general remarks about the psychology of dreams are necessary. It will suffice my purpose to refer only to its general nature and its importance from the point of view of the New Psychology. Other considerations like the significance peculiar to different types of dream-contents which differ according to the difference in the age of the dreamer as also with his intelligence, and even with different walks of life; or say, the effect of dreams in the psychological development of the individual; or, dreams in their relation to the actual life of the individual—these are details which can safely be omitted for the present.

It is not too much to say that everybody who sleeps dreams, and everybody who breathes sleeps. Children dream, adults—men and women—do dream, a professor dreams but a toilworm craftsman dreams too. And an honest beggar is a dreamer perhaps of far more pleasant dreams than those of a wealthy wretch. Even dogs dream, they say. Dream-experience, in short, is too common to be introduced as something strange. But it is this very feature of universality that has undermined its importance to a considerable extent. The laity is prone to look upon any attempt to understand and interpret dream-experience on scientific lines rather as much ado about nothing. Indeed it is to the great credit of psycho-analysts that they have been strongly emphasising the peculiar bearing of this aspect of mental activity upon the working of mind in general. It may be noted then as the first characteristic of the phenomenon of dreams that from the point of view of dreaming we are all children of one God.

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1. It should be noted that on these points there seems to be general agreement between Nicoll (*Dream Psychology*), Tansley (*The New Psychology*), and Rivers.
 2. James, *Principles of Psychology*, New York, 1890, Vol. II, p. 294.

As for the immediate causes of dreams, we find it possible to account for them in terms of external sense-impressions, or internal, i. e., organic, stimuli, or sometimes both. The nature and intensity of the recent experience too weighs a good deal in bringing about dreams, though naturally their influence is felt through one of the causes already stated. Dreams, as Freud would say is a phenomenon that is 'hyper-determined.'

Further all dreamers know that dream experience differs in kind from waking experience. We speak of even the dream-consciousness as distinct from the waking-consciousness. It is this dream-consciousness which tries to systematise the dream-contents, though the waking consciousness may, with all vehemance, stigmatise the dream as an incoherent whole.

Again it is also well known that X cannot have direct access to the dream experience of Y, nor Y to that of Z, nor Z to that of X. Dreams are not amenable to external observation. But it is also true that X, Y, and Z are not wholly unconscious of their *dreams*; otherwise it would not be possible for them to relate their dreams in the waking state. And here we at once come to think of the link between the dream life and the waking life. It is at this stage that we strike upon the point of fusion of the dream consciousness and the waking consciousness.

The following diagram may conveniently aid in visualising this contact. Imagine two circles, one smaller than the other, touching at the point O through which a common tangent is made to pass. The straight line AB joins the two centres through O, the point of contact.

Life, Dreaming, and Consciousness

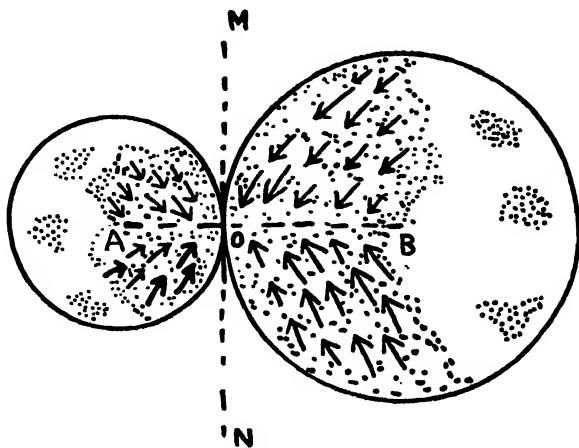


Fig. 2.

I have represented the dream-life by the smaller circle mainly because I am not here concerned with the abnormals and experimental dreams. My main concern, it will be observed, is with normal minds and spontaneous dreams. And the part of life we spend in dreams is supposed to be much less than that covered by the waking life. Leaving aside the exceptions that we come across in the form of dual personalities, the life of an individual is generally taken to be a unity, and in the figure the line MON represents the general stream of life that accounts for the individuality or the unity of the life of an individual. The point O represents the momentous present which is, as Leibnitz says, 'big with the future and laden with the past'. It is at this point that the contact takes place. When we speak, for instance, of their dream-experiences being related by X, Y or Z respectively, we imply a link between the dream-consciousness and the waking consciousness of each, that is to say, we at once admit the possibility of bridging the gap that severs the two as two experiences differing in kind. This bridge is formed by that highly important mental activity, viz., memory. I have said that the line AOB represents the line of memory, O being the point where it touches the straight line MON which represents the general stream of life. Thus from the point of view of Life, Memory, like the 'present', has a peculiar temporal significance. As J. S. Haldane observes, 'Memory is indeed a meaningless word apart from conscious experience of a past in personal relation to a present'.¹ Forgetting is common to both the types of experiences² and in the figure the dotted clusters—*a, b, c; a', b', c'*—may be taken as representing the forgotten experiences, if such an expression be allowed. Now, 'What is forgotten?' and 'What is remembered?' are questions that touch the fabric of human life almost at every point in its texture and thus are too wide to be discussed here. Moreover, they fall outside

1. *The Philosophy of a Biologist*, Oxford, 1935, p. 81. Cf. Bergson, 'Our memories, at any given moment, form a solid whole, a pyramid, so to speak, whose point is inserted precisely into our present action. But behind the memories which are concerned in our occupations and are revealed by means of it, there are others, thousands of others, stored below the scene illuminated by consciousness' (*Dreams*, London, 1915 impr., pp. 36-37).
2. 'All those factors which produce forgetfulness in the waking state are also determinant for the forgetting of dreams' (Freud, *Interpretation of Dreams*, London, 1913 ed. p. 36).

It should be noted that this phenomenon had not escaped the notice of Plato; but the form in which we have it is rather rudimentary. See Brett's *History of Psychology*, Vol. I, p. 77.

my immediate purpose. Suffice it to say that what is remembered and what is forgotten has, besides many other causes¹, a vital relation to the individual's interests² in life. It needs to be added here on the strength of what has been already said that even in the most faithful account of a dream by the dreamer himself, the possibility of distortion cannot altogether be ignored. The distortion³ itself is likely to be unconscious in the sense of being not deliberate.

To sum up the discussion on the topic of dreams :

- (i) Dreams are a pretty universal phenomenon.
- (ii) Dreams differ as to their contents according to age, the degree of intelligence, and the different spheres of life.
- (iii) From the point of view of the waking state, dreams are partly unconscious and partly conscious.
- (iv) Dreams defy external observation.
- (v) Memory constitutes the link between the dream consciousness and the waking consciousness, with a very strong possibility of distortion of the nature of the dream contents and their significance (as related by the dreamer). This possibility is all the more enhanced because the nature of the contents of dreams often differ very widely from the actualities of the waking state, though on closer observation the relation may come to be as meaningful as that between a political cartoon and the actual political situation.⁴

On the admission of Freud himself, it is the theory of dreams that marks a turning-point in the history of psycho-analysis.⁵ To lay down the theory in full and to describe it in all the possible or even the known ways would need for itself a monograph. Freud

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1. Soundness of sleep, for instance, so far as dreams are concerned.
 2. The word 'interests' is here to be understood in its popular sense : technically, in view of certain associations, it cannot be used without defining its meaning with reference to the context.
 3. Understood in its Freudian sense, there are differences of opinion regarding this feature of the Freudian theory of dreams. Rivers suggests the word 'transformation' instead (*Conflict and dream*, London, 1923, p. 4). See also Tausley, *The New Psychology*, 9th impr., London, 1924, pp. 141-42.
 4. Nicoll has finely compared dreams with cartoons. See his *Dream Psychology*, 2nd edition, London, 1920, especially chapter IV, p. 23 ff. Also see for the general nature of dreams Kimmins, *Children's Dreams*, London, 1920, chap. II, p. 20 ff. and Diblee, *Instinct and Intuition*, London 1929, chap. XV, p. 267 ff.
 5. *New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 15.

indeed is a master hand at graphic exposition. But picturesque descriptions are, more often than not, elusive and suffer from the concomitant danger of inexactitude. Freud's exposition is all the more so. It is quite nice to speak of the waking, sleeping, or even standing and sitting, ego, for instance, on the public platform and for the effective narration of the Freudian discoveries. But for theoretical description in scientific language this multi-faced ego proves quite an insurmountable obstacle, and in his struggle to remain consistent at least with himself the ego of the scientist is almost shattered to pieces. Nearly three-fourths of the Freudian literature would not have been there, only if Freud had taken care to be scientifically precise and unequivocal in the statement of his views. Under these circumstances I must be content with mentioning only the outstanding features of his theory.

Freud distinguishes between the manifest and the latent content of dream. What the dreamer experiences during the dream and relates afterwards is not all that the dream means, but it forms only the explicit or the manifest content of the dream. It is only the superficial radiation of what lies hidden in the depths of the psyche and which is really experienced in a dream. It is this alleged relation between the explicit and the implicit content that constitutes the foundation of the Freudian method of interpreting dreams. The manifest content derives all its value from its character of being the symbolic expression of the latent content. Closely allied to this is the conception of dream-work which is perhaps the most scientifically developed aspect of the Freudian theory of dreams. Dream-work is the name given by Freud to the processes employed by the mind during the actual course of the dream, the product of it being the transformation of the psychic material in such a manner that ordinarily the real meaning of the dream eludes recognition. It is here that we come across the all powerful multi-coloured censor of Freud. It is to this censor, the 'endo-psyche repulsion' ('Interpretation of Dreams', p. 287), that Freud attributes the essential part of the dream-work. 'Dream formation takes place under the sway of a censorship which compels distortion of the dream thoughts.'¹ This distortion, as I have already pointed out, is a characteristic of the Freudian theory which on the view of Rivers and others needs to be modified.

Another important and perhaps the main feature of Freud's theory is that every dream is a vehicle by means of which the individual tries to fulfil his heart's desire or desires which

1. Freud, *Collected Papers* Vol. IV, p. 54.

generally belong to the repressed stock. 'The dream represents the fulfilment of a wish, often of a concealed wish repressed from consciousness during waking life, and expressed in the dream symbolically by a series of dream pictures, thoughts and actions.'¹ Dream interpretation thus consists in laying bare the nature of the wish-fulfilment characterising different dreams. First and foremost, dreams are, for Freud, symbolic representations of wish-fulfilments.²

Let us now turn to Plato. I have sufficiently explained the nature of the possible conflict between the three different aspects of the human soul as it is conceived by Plato. We have to bear in mind this aspect of the Platonic thought along with his doctrine of Eros when we come to consider that passage from the *Republic* in which Plato recognises dreams in a way that is significantly characteristic of modern times.³

I have no reason to go into details of the *Republic*. A few

1. Tansley, *The New Psychology*, 9th impr., London 1924, p. 133.
2. Freud has replied to the criticism on this aspect of his theory in a very characteristic manner. In his *New Introductory Lectures on Psycho-Analysis*, Freud writes, 'The most hotly disputed point of the whole theory was undoubtedly the assertion that all dreams are wish fulfilments. We have kept our theory *intact* by dividing dreams into wish-dreams, anxiety-dreams, and punishment-dreams' (Underline mine, p. 41). I fail to understand 'how?'. For criticism on this point see Tansley, *The New Psychology*, 9th impr., London, 1924, chap. XII, esp. p. 133 ff.
Also Rivers, *Conflict and Dream*, London, 1923, chap. IX esp. p. 153 ff.
3. Freud has referred to Plato's recognition of dreams in connection with an important issue. Discussing 'The Evil in Human Nature,' Freud observes, 'What does psycho-analysis do in this connection but confirm the old saying of Plato that the good are those who content themselves with dreaming of what others, the wicked, actually do (*The Interpretation of Dreams*, London, 1913 ed., p. 122). Reference to the same fact is again to be found where Freud finds fault with the Roman emperor for executing a subject who dreamt that he had killed the emperor without endeavouring to discover the significance of the dream (*Ibid.*, pp. 492-493). These references, it will be observed, are highly significant with one of the important features of the Freudian theory of dreams already considered, viz., the wish-fulfilment. They are also noteworthy from the point of view of what Kimmins has to say on 'Dreams and Intelligence': 'Within certain limits, the frequency of dreaming among healthy people varies with the state of development of the intelligence.' (*Children's Dreams*, London, 1920, p. 27). And 'Generally speaking, dreams increase with the variety and activity of the intellectual life' (*Ibid.* p. 28).

observations, however, are necessary to enlighten the passage to be quoted.

The Republic is at once a moral, a sociological, and a political treatise. For Plato, like Socrates, morals and politics are not two bundles separable at will. Ethics forms the foundation and perhaps the only foundation of the politics of Plato. And that is exactly the reason why Plato's *Republic* proved a Utopia for the faltering, if not immoral, humanity. It is indeed surprising that Plato, with all his intellectual powers, failed to apprehend what Hobhouse realised : 'A general degradation of type is suitable to the parasite, and the thick-skinned man gets on best in the world'.¹ Whatever may be its worth for the petty politicians or the social retrogrades, the *Republic* does embody a comprehensive system laid down by a great man who was pining, all his life, to improve the lot of man. The descriptions and prescriptions, the diagnosis as well as the remedies, regarding the fundamental problems of life that we find there bear a very genuine connection to the living reality of the Platonic times. The *Republic* is no frantic fantasy : It is Plato's life-blood.

The passage which follows is perhaps even more real as it has a personal significance from the point of view of Plato's own life. In that part of the *Republic* (Books VIII-IX) where this passage occurs, Plato is delineating the various stages of the progressive degeneration of an individual as well as of a nation. There Plato has before his mind the origin of the Sicilian tyranny, the life of the tyrant whose despicable living Plato witnessed with his own eyes, and from the effects of which he actually suffered. In the Platonic system of the levels of degradation, tyranny follows democracy, and before he portrays the character of the tyrannical, Plato digresses to speak of the 'appetites'. It is to the lack of proper understanding of the nature and growth of these 'appetites' that Plato attributes the muddling of politics and turns to dreams for some aid in their understanding. The passage runs :—

(The two parties to the dialogue are Socrates and Adeimantus. The passage² opens the Book IX of the *Republic*. I shall put in italics and mark with letters the significant parts of the passage for explanation in what follows).

' Last of all comes the tyrannical man, about whom we have once more to ask, how is he formed out of the democratical ? and how does he live, in happiness or in misery ?

1. *Mind in Evolution*, London, 1926, p. 3.

2. Jowett, *The Republic of Plato*, Oxford, 1888, p. 280-81.

‘ Yes, he said, he is the only one remaining.

‘ There is, however, I said, a previous question which remains unanswered.

‘ What question ?

‘ I do not think that we have adequately determined the nature and the number of the *appetites*^a, and until this is accomplished the enquiry will always be confused.

‘ Well, he said, it is not too late to supply the omission.

‘ Very true, I said, and observe the point which I want to understand : *Certain of the unnecessary pleasures and appetites I conceive to be unlawful^b; every one appears to have them^c, but in some persons they are controlled by the laws and by reason^d, and the better desires^e prevail over them—either they are wholly banished or they become few and weak, while in the case of others they are stronger^f, and there are more of them.*

‘ Which appetites do you mean ?

‘ I mean *those which are awake when the reasoning and human and ruling power is asleep^g*, then the wild beast within us, *gorged with meat or drink^h*, starts up and having shaken off sleep, goes forth to satisfy his desires, and there is no conceivable folly or crime—not *excepting incest or any other unnatural union or parricideⁱ*, or the eating of forbidden food—which at such a time, when he *has parted company with all shame and sense^j*, a man may not be ready to commit.

‘ Most true, he said.

‘ But when a man’s pulse is healthy and temperate, and *when before going to sleep he has awaked his rational powers^k*, and fed them on noble thoughts and enquiries, collecting himself in meditation, after having first indulged his appetites *neither too much nor too little^l*, but just enough to lay them to sleep, and prevent them and their enjoyments and pains from interfering with the higher principle—which he leaves in the solitude of pure abstraction, free to contemplate and aspire to the knowledge of the unknown, whether in past, present, or future. When again he has allayed the passionate element, if he has a quarrel against any one—I say, when, after pacifying the two irrational principles, he rouses up the third, which is reason, before he takes his rest, then, as you know, he attains truth most nearly, and is least likely to be the sport of fantastic and lawless visions.

‘ I quite agree ’.

Before I say anything of my own on this passage, I must reproduce the pointed observations of Gomperz on this part of the

Republic which are directly relevant to my purpose. Gomperz writes : ¹

‘As if to lay still deeper foundations for this momentous decision,² Plato (at the beginning of the ninth book) seeks the tyrannical nature in process of manufacture. Two generations are required for its production. Its growth is caused by the more and more luxuriant development of passions for which democracy (here looked at with a more lenient eye, as the foil of tyranny) had prepared the ground. *The wild beast which sleeps in every man, and at times, especially by night, awakes to rage and roar, is freed from every restraining curb; the herd of ‘wild and mutinous desires’ is let loose.* Out of the many passions one comes forward as master, as the ‘tyrant within the Soul’ and the other desires form its body-guard. *Here, too, are soon enrolled the baser tendencies once repressed, but now emancipated; the good impulses which resist them are killed or banished; the man’s soul is purged of temperance’.*

The passage from Plato is important not only from the point of view of Psycho-Analysis but even from that of general psychology. For a psycho-analyst of the Freudian school, it should read ultra-modern. Plato’s plea is for the same kind of life which Havelock Ellis advocates when he says ‘the whole art of living lies in a fine balance of expression and repression’. The immediate goal of Psycho-Analysis is to improve the condition of the abnormal by trying to restore mental equanimity and to apply ultimately the knowledge of mind thus gained to ensure conditions which will secure normal life for as many as possible. To appreciate its full meaning the passage needs to be analysed on psycho-analytic lines.

(a) Without transgressing the limits of sane interpretation, ‘appetites’ can be understood to mean the primitive instincts or the crude impulses of Freud.

(b) ‘Certain.....unlawful’.

Plato is undoubtedly referring here to the extravagant indulgence in sensual pleasures. I would not interpret the word ‘unlawful’ as implying anything socially or politically ‘illegal’ in the modern sense of the term. As I have already suggested, for Plato morals and politics are one. ‘Unlawful’ should mean ‘against the dictates of Reason—Reason which is always eager to provide the maximum possible scope for the development of the personality of the individual in society. It should be well realised, as I

1. *Greek Thinkers*, London, 1905, Vol. III, p. 98.

2. This refers to certain preceding remarks of Gomperz. Italics Mine.

shall presently show, that Plato is not professing to preach asceticism.

(c) 'Everyone appears to have them'.

Here Plato asks us to get rid of the idea that the birth of an individual seals his lot, that the great are born, and that saints are never made. Plato, it must be remembered, was not slow to realise in the fourth century B. C. what James wrote on the eve of the twentieth: 'Habit is the enormous fly-wheel of society, its most precious conservative agent'.¹ Plato does seem to believe that man is the architect of his own fortune. Plato's is a plan of life grounded on formal and healthy optimism. He lacked only the Freudian apparatus. The poor as well as the rich, the dunce no less than the wise, the saint equally as the wretch, the young and the old alike—everyone is possessed of these 'appetites'. But for them Morality and Progress would be meaningless epithets: The human soul would for ever be shorn of its sweet beauty.

(d), (e), (f) taken together would represent something like the ego, super-ego, and the censor of Freud. By the term 'laws' taken separately I would understand especially censorship of the ego—censorship which, as Rivers puts it, is 'a social process',—though reason is the fundamental factor in the genesis of the 'laws'. Something definitely corresponding to the Freudian censor, we get below. By 'reason' taken by itself, I would rather understand the super-ego. Collectively, the expression 'laws' and 'reason' should be taken to connote the 'censor' which serves the ego rather than the super-ego which rules it. It is indeed presumptuous to try to read everything Freudian in the language of Plato. Better look at Adam for the features of Freud! This is far from being my ambition. My task is simple: to submit the possible interpretations, which claim to be no more than tentative, of the Platonic writing before me. To proceed, where shall we find the ego? It is I submit, in the 'better desires' understood as one bundle working in co-operation with the 'laws' and 'reason'. On the same logic I understand the rest of the paragraph. The 'Unconscious' is formed by those 'appetites' which are 'wholly banished'; or which 'become few and weak,' or which 'are stronger'. The expression 'wholly banished' cannot be taken literally. Nature denies us the power of destroying any of our innate endowments in that sense, at the same time bestowing upon us the gift of intelligence for their betterment. The words 'everyone appears.....become few and weak' represent pretty well the idea of the process of sublimation—which

1. James, *Principles of Psychology*, New York, 1890, Vol., I, p. 121.

for Freud means a use of psycho-sexual energy only.' This is all about the so-called normal people who admit of various degrees. We get next a reference to the socially abnormal and the neurotics where Plato says that 'in the case of others they are stronger, and there are more of them' (they and them for 'appetites').

(g) The expression 'Those which.....ruling power' (underline mine) very directly anticipates the conception of the Freudian censor.

(h) In the expression 'Gorged with meat and drink' Plato seems to admit the organic causation of dreams. (See the general nature of dreams discussed above.)

(i) 'Not except incest.....parricide'. This expression most definitely corresponds to the Freudian credo of the Oedipus complex.

(j) 'Has parted.....sense'.

The unconscious becomes too active and strong for the control of the censor and guidance by the ego and the super-ego.

(k) and (l): Here Plato clearly appears to admit the substantial influence of the immediately previous occurrences, especially thoughts and actions, on the possibility and nature of dreams. This whole paragraph is highly significant. It shows Plato advocating, in a very practical manner the ways and means of a balanced life as also its effects. Hume, too, sounds the same note in his '*An Enquiry concerning Human Understanding*' when he advises: 'Be a philosopher; but, amidst all your philosophy, be still a man.'¹ And what else is the advocacy of that philosopher-sage Spinoza? He tells² you: 'To make use of things and to delight in them as much as possible (provided we do not disgust ourselves with them, which is not delighting in them), is the part of a wise man. It is the part of a wise man, I say, to refresh and invigorate with moderate and pleasant eating and drinking, with sweet scents and the beauty of green plants, with ornament, with music, with sports, with the theatre, and with all things of this kind which one man can enjoy without hurting another. *For the human body is composed of a great number of parts of diverse nature, which constantly need new and varied nourishment, in order that the whole of the body may be equally fit for everything which can follow from its nature, and consequently the mind may be equally fit to understand many things*

1. '*Enquiries*,' Oxford, 1902, p. 9.

2. '*Ethic*', Part IV, Schol. to corol., 2 of Prop. XLV. Italics Mine.

at once. This mode of living best of all agrees both with our principles and with common practice ; therefore this mode of living is the best of all, and is to be universally commended'.

(c) THE DOCTRINE OF REMINISCENCE (The *Meno*).

Plato's doctrine of Reminiscence, which is explicitly stated in the *Meno*, is closely related to his theory of Ideas. Its basis, for all practical purposes, does appear to be the immortality of the soul but how far does it determine the genuine character of the doctrine is a dubious question. From the point of view of the general trend of the Platonic thought, its relation to the immortality of the soul does not seem to be very significant. What needs to be emphasised is its relation to the theory of Ideas. Plato's belief in the immortality of the soul is, as yet, far from being confirmed.¹ But there are no two opinions about the Platonic character of the theory of Ideas. The soul of Plato's philosophy is his doctrine of Ideas. The doctrine of Reminiscence, in short, savours more of a metaphysical, and in a sense even a mythical, strain than of a psychological character. As it falls, therefore, outside our direct concern, it need not detain us long.

The doctrine presents a double character ; it can be interpreted from the point of view of the pre-existence or immortality of the soul, as also, from the side of the important distinction between the conceptual and the perceptual. The soul being immortal, the span of its existence in human form is but a part for its history. And before it started its bodily existence, it must necessarily have been in direct contact with the World of Ideas, when it must have been in possession of the entire 'knowledge'. But in human form it finds itself in a state of oblivion. It is no more in direct sight of the Ideas, but the capacity to revive the memory of the former experience is not lost. What is necessary is a go-between and it is the sensuous perception that helps the soul here. The sensuous perception, through 'reminiscence', provides the human soul with a clue that may, if it be properly utilised, enable it to regain the knowledge of Ideas. Learning thus becomes 'recollection'. This is all what the doctrine means in plain language.

It is on this plain, or better superficial, meaning that Montmasson² seems to have based his interpretation. He has neglected to take note of the scientific, which is also the Platonic, side of the doctrine. Montmasson sees in this doctrine, 'The germs' of what he calls 'The distant or palingenetic unconscious'.

1. Zeller, *Plato and the Old Academy*, London, 1888, p. 410.

2. Montmasson, *Invention and the Unconscious*, London, 1931.

He observes in this connection; 'The perceptions of the senses are the recollections of ideas known to souls before their union with bodies. Now these particular souls arise by emanation from the cosmic soul or God. The theory of reminiscence implies a certain unconscious participation by the soul in Divine truth. The actual conscious soul is, as it were a degradation of the Divine principle from which, unknowingly, it derives its origin. It is this primitive existence, this distant unconsciousness, which explains the doctrine of reminiscence' (p. 12). This point of view needs our attention for two reasons: first, Montmasson has distinguished 'The theories relating to the impersonal or *metaphysical* unconscious' from what he calls 'the Hypotheses of the *distant* or *palingenetic* unconscious'; and secondly, from the point of view of this distinction, he interprets Plato's doctrine of Reminiscence as belonging to the category of 'distant' or 'palingenetic unconscious because it is based on and explained by the assumption of the 'primitive existence of the soul'. I am not questioning in the least the distinction made by Montmasson. My difficulty is whether, even on such a distinction Montmasson's interpretation of Plato's doctrine of Reminiscence is satisfactory. For, as I have already remarked, the close relation of the doctrine to the theory of Ideas is far more significant than its superficial connection with the idea of pre-existence.

It is not possible here to discuss the relevant parts of the *Meno*. But a summary account is necessary. In his introduction to the *Meno*, Jowett writes,¹ 'This dialogue contains the first intimation of the doctrine of reminiscence and of the immortality of the soul. The proof is very slight, even slighter than in the *Phaedo* and *Republic*. Because men had abstract ideas in a previous state, they must have always had them, and their souls therefore must have always existed (86A). For they must always have been either men or not men. The fallacy of the latter words is transparent. And Socrates himself appears to be conscious of their weakness; for he adds immediately afterwards, "I have said some things of which I am not altogether confident" (Cf. *Phaedo* 114 D, 115 D). It may be observed, however, that the fanciful notion of pre-existence is combined with a true but partial view of the origin and unity of knowledge, and of the association of ideas. *Knowledge is prior to any particular knowledge, and exists not in the previous state of the individual, but of the race. It is potential, not actual, and can only be appropriated by strenuous exertion*" (pp. 8-9, Italics Mine).

1. *The Dialogues of Plato*, Oxford, 1892, Vol. II.

On the points which I have been trying to emphasise, a few observations from A. E. Taylor¹ may be subjoined to make the matter clear. Taylor, in an explanatory note on this doctrine, observes :

'As we are encountering the doctrine of "recollection" for the first time it is worth while to note what the exact point of it is. It must be observed that it is not a theory of "innate ideas" or "innate knowledge", in the popular sense of the words. We are not supposed to bring any actual knowledge into the world, ready-made with us. On the contrary, we are said to have learned truth but to have lost it again, and we have to recover what we have lost. The recovery requires a real and prolonged effort of steady thinking; what "recollection" or more accurately "being reminded" does for us is to provide the starting point for this effort..... The main emphasis thus falls not on the Orphic doctrine of pre-existence and re-incarnation.....but on the function of sense-experience as suggestive of and pregnant with truths of an intelligible order which it does not itself adequately embody or establish. And the philosophical importance of the doctrine is not that it proves the immortality of the soul, but that it shows that the acquisition of knowledge is not a matter of passively receiving 'instruction', but one of following up a personal effort of thinking once started by an arresting sense-experience' (p. 136). Thus we clearly see how superficial is the connection between the doctrine of reminiscence and the notion of pre-existence. But the bond between the former and the theory of Ideas is yet to be positively established.

Taylor may again be quoted with profit. Commenting on 'The Argument from the Doctrine of Reminiscence' in the *Phaedo* Taylor writes :

'One should note several things about the way in which the doctrine of the 'forms' is introduced into this argument. For one thing, we see that there is no room in the theory for "innate" ideas in the strict sense of the word, and that there is no question of a knowledge acquired independently of experience. The whole point of the argument is that we should never be "put in mind" of the "forms", but for the suggestion of the senses. Again, the most important feature of the process of "being reminded" is that sense perceptions suggest standards to which they do not themselves conform.. ... These two considerations, taken together, show that the theory does full justice to both parts of the *Kantian*

1. *Plato : The Man and His Work*, 2nd ed., London, 1927.

Dictum that "percepts without concepts are *blind*, concepts without percepts are empty" (p. 188).

But it may rightly be asked: Whatever its basis may be, what is the exact bearing of this doctrine of Reminiscence on the hypothesis of the unconscious or the subconscious? To this I reply at once that this bearing is neither very close nor direct, and consequently the proof cannot be very convincing. All the same, it is a means by which 'Plato endeavours to solve the problem' the problem of knowledge—'by what is practically a reference to the sub-conscious. He extends the meaning of knowledge so as to make it include, not merely actual conscious knowledge, but also the knowledge we possess without being aware of it.'¹ It is in this doctrine of Reminiscence that consists 'The nearest approach Plato makes to the notion of subconscious states.'²

And now I submit the following considerations with regard to this Doctrine of Reminiscence. From the side of the idea of primitive existence the doctrine appears to be no more than a mythical projection of Plato's religious, or may be even moral, views which he finds conducive to the health of man. From the point of view of the theory of Ideas, the doctrine is, more or less, metaphysical in character. But both these views would well subserve an interpretation which is more psychological than either, viz., that the doctrine without any distortion, may be brought under the category of what we have described as the Innate, or what Montmasson calls³ the 'Hereditary', unconscious. We might go even further to hazard a conjecture that the doctrine of Reminiscence comes very close to the conception of biological memory⁴.

Aristotle (384-322 B.C.).

Here I leave Plato and pass on to his disciple, Aristotle who 'outstrips his master in all those qualities which mark the full manhood of science.' I have had an occasion to refer to Aristotle as the founder of scientific psychology. Now this psychology founded by Aristotle is objective, or as Hoffding puts it 'experimental,' in kind. The method employed by Aristotle is in essence

1. R. Latta, *The Significance of the Subconscious, Proceedings of the Aristotelian Society*, N. S., Vol. III, p. 189.
2. Brett, *History of Psychology*, Vol. I, p. 77.
3. *Ibid.*, p. 302.
4. The problem of biological memory has been excellently discussed by Rignano. See his *Biological Memory*, London, 1931, esp. chaps. XII, XIII & XIV.

empirical. Here it is possible to take note of Aristotle the psychologist only from three points of view, viz.,

- (a) The meaning of Dreams ;
- (b) The conception of Catharsis; and
- (c) The Bipartite division of Reason which, for Aristotle, is peculiar to man.

(a) ARISTOTLE ON DREAMS.

Aristotle was perhaps the first to realise the importance of dreams as a psychological phenomenon. Freud's own recognition of this fact has already been mentioned¹. Neither is it possible nor necessary for our purpose to undertake a critical scrutiny of Aristotle's ideas about dreams. It shall be my endeavour only to show how far and in what sense dreams were looked upon by Aristotle as the product of the subconscious (or unconscious) mental processes.

It is advantageous to bear in mind from the beginning certain drawbacks of the Aristotelian thought. Aristotle tried his hands at a good many things with the result that the spirit of system seems to have lost its control in respect of some important aspects of his thought: He huddles up together, for instance, dream-pictures and memory-pictures under the one category of the "Phantasies" or "phantasms". And, as Gomperz has pointed out the treatment of sleep and dreams is again weakest at the point where physiological explanations are attempted². But Aristotle's dream psychology, it needs to be remembered, is not to be criticised for its shaky structure, it is as the scientific foundation of the study of a significant mental phenomenon that it deserves credit.

1. For Freud's reference to Aristotle in connection with the phenomenon of dreams see the following :

- (1) *Interpretation of Dreams*, London, 1913, p. 27. Reference to Aristotle's acquaintance with the fact that dreams make us sensitive to incipient morbid conditions which fall outside the focus of attention during the waking state.
- (2) *Collected Papers*, Vol. IV, London, 1925, p. 150. Aristotle referred to as recognising the important fact that dreams are the mental activity of the sleeper'. See also *New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 27.
- (3) *Introductory Lectures on Psycho-Analysis*, London, 1922, p. 71. Reference to the same fact.

Zeller corroborates this. See his *Aristotle*, London, 1897, Vol. II pp. 76-77.

2. *Greek Thinkers*, London, 1912, Vol. IV, p. 184.

It is not very easy to form an exact estimate of the Aristotelian conception of Mind. Consciousness is not the central feature of the Aristotelian apprehension of psychical facts. 'Soul' is the central concept with Aristotle. But even here he has his own way of looking at it. The soul, as Aristotle thinks of it, is neither to be identified with body nor with mind but is something which explains all vital processes manifested in the life of plants, animals, and man. In this hierarchy, the human soul is at the apex. It is endowed with Reason in addition to the other qualities which it has in common with either of the remaining types of vital processes. As the most perfect of the three, the human soul is also the most comprehensive. Man thus being Nature's most perfect product, Aristotle thinks that the study of the principle of Reason or thought which is essentially human would embrace all psychological problems.

Aristotle thus gives us no comprehensive theory of Mind which can be called psychological in the modern sense of the term. Human soul, as Aristotle conceives it, may be taken to stand for what we call mind. And further it must be observed that the confusion which surrounds the Aristotelian conception of the human soul or consciousness also inheres in his ideas about the non-conscious or unconscious. Even the principle of motion which dominates Aristotelian thought in almost all its aspects does not leave uninfluenced even his account of the phenomenon of dreams.

'The dream proper', as Aristotle defines it, 'is a presentation based on the movement of sense impressions when such presentation occurs during sleep, taking sleep in the strict sense of the term'. Along with this definition three other observations of Aristotle on the same subject are worth noting. First, 'Dreaming is an activity of the faculty of sense-perception, but belongs to this faculty *qua* presentative'. Secondly, 'It is inevitable that, as a change is wrought in them in proportion to age or emotional experience, this reversal (from non-dreaming to dreaming) should occur also'. Thirdly, 'A vision occurs when sleep comes over us when we are thinking or letting things pass before our eyes. Hence we usually see things which we are doing or intend or wish to do, for it is on these things that our thoughts and fancies most often dwell. *And the better men are the better are their dreams, because they think of*

1. *The Works of Aristotle*, Oxford, 1931 ; *De Somniis*, 462 a, 29.

2. *Ibid.*, 459 a, 21.

3. *Ibid.*, 462 a, 10.

*better things in their wakening hours, while those who are less well disposed in mind or body have worse dreams.'*¹

Notwithstanding its defects, Aristotelian idea of dreams, as it can be understood from the foregoing citations does not seem to be at wide variance with the modern conception in general or the Freudian in particular.

Aristotle's definition along with the first passage stands in good comparison with the following observations of Freud: 'The state of sleep represents a turning away from the real external world, and thus provides a necessary condition for the development of a psychosis..... The harmless dream-psychosis is the result of a consciously willed², and only temporary withdrawal from the external world; it ceases to operate when relations with the external world are resumed. While the sleeper is isolated, there is an alteration in the distribution of his psychic energy; part of the repressive expenditure which is otherwise used to keep down the unconscious, can be saved, for if the unconscious makes use of its relative freedom and enters on some activity, it finds the avenue to motor expression stopped up, and only the innocent outlet of hallucinatory satisfaction open to it'. As can be gathered from the second passage quoted above, Aristotle seems also to have grasped the relation of dreams to the difference in age (though it is difficult to be exact about the extent of the 'non-dreaming' period of life of which Aristotle speaks), and to the change of emotionality.

The last among the passages cited above is perhaps the most important. It is very clearly reminiscent of Plato's words which I had an occasion to refer to.³ Its resemblance to the Freudian idea of wish-fulfilment in connection with the nature of dreams, though not exactly identical, is quite close.

(b) THE THEORY OF CATHARSIS (OR KATHARSIS).

The direct historical leanings of Psycho-Analysis are traced back to Breuer (1842-1925), a medical practitioner in Vienna. It is in the early eighties of the last century that Breuer is supposed to have laid the foundations of the psycho-analytic

1. *The Works of Aristotle*, Oxford, 1927. *Problemata* 956b—957a. Italics mine.
2. Characterising sleep as a consciously willed phenomenon is one of those points in the Freudian theory of dreams which cannot be easily accepted.
3. See above, p. 118.

method.¹ It was while treating a hysterical girl-patient that Breuer came to hit upon this particular line of procedure. He discovered that the many symptoms which were observable in his patient were not without meaning; the symptoms were significantly related to certain of her past experiences which she no more remembered. Breuer further observed that when the patient was in the hypnotic state, the memory of these particular experiences could be revived—this revival acting at least as a temporary antidote and thus bringing about a considerable relief in the mental condition of the patient. Thus the method as it was conceived by Breuer consisted essentially in the revival of pathogenic memories under the influence of hypnosis enabling the patient to re-experience in consciousness the relevant emotions. The actual process is called 'abreaction', and the line of procedure goes by the name of 'cathartic' method.

It is from the point of view of this historical fact that the Aristotelian conception of 'Catharsis'² derives its significance. It is with reference to the theory of Art (which includes even Tragedy as an artistic production) that Aristotle speaks of this theory of 'Catharsis'. But the end in view is ethical in character: The idea is to excite the passions of man for the effective self-purification of the soul. This Aristotle-Freud relation has been referred to by Flugel as well as Cyril Burt in definite terms. Referring to the 'Cathartic' method Flugel writes³: 'This procedure obviously has some resemblance to "confession" as practised by the Roman Catholic Church (though freed from the moral and theological implications of this latter) and—going further back to the function of tragedy, as expounded by Aristotle, who had taught that tragedy produces a healthful "purging" by intense arousal of the emotions of "pity" and "terror"'. And

1. To suit his needs, Freud has improved immensely upon the method inaugurated by Breuer. Here it is neither possible nor necessary to examine the method in its details. What needs to be observed is that the psycho-analytic method of Freud has its genesis in the 'Cathartic' method of Breuer. Freud has recognised the fact more than once. See, for instance, his *Collected Papers*, Vol. I, London, 1924, p. 244.
2. Burnet writes: 'Aristoxenos tells us that the Pythagoreans employed music to purge the soul as they used medicine to purge the body, and it is abundantly clear that Aristotle's famous theory of Katharsis is derived from Pythagorean sources' (*Early Greek Philosophy*, London, 1908, p. 107).
3. *A Hundred Years of Psychology*, Duckworth, 1933, p. 280.

Burt observes¹: 'The idea that the mind is eased by working off, and purging itself, as it were, of any unwholesome excitement is as old as Aristotle; and Aristotle's term has been adopted to designate this therapeutic process. It is commonly described as the "Cathartic method" '.

(c) THE BIPARTITE DIVISION OF REASON.

The modern idea of mind is comprehensive enough to include within its compass not only consciousness, i.e., conscious mental processes with their product, but also the unconscious mental activity which manifests itself in different forms. In other words, to-day an adequate study of mind necessitates the consideration of what Malinowski calls 'the unofficial and unacknowledged sides of human life'.² This view of mind is one of those important things for which Freud and the psycho-analysis in general deserve great credit. But we are on the wrong track if we think that this deep insight with regard to our mental life was entirely beyond the mental horizon of the thinkers of the past. That they have not given us a dynamic theory of mind in a concrete form or that the systematic exposition of their ideas about mind and its working which have come down to us fail to stand the test of practical application to the variety of mental phenomena are quite different matters. To condemn their achievements on these counts is to show complete ignorance of what the progressive development of man means.

Mind, or what Aristotle calls human soul, has two aspects; active and passive. Reason, especially as the capacity to reflect, is the form characteristic of this human soul. The vital processes which man possesses in common either with the lower animals or plants furnish the material for the realisation of this form. It is this Reason which enables man to lead what we call a higher kind of life. Again it is through its influence that impulse grows into will, knowledge is formed out of imagination. Now this activity distinctive of the human soul, Aristotle thinks, comes 'from without'. He designates it as the active, or creative, reason in contrast with passive or receptive reason which stands for everything plastic and is worked upon by the *active reason*. 'The 'passive' reason signifies the *individual phase* (*Erscheinungsweise*) given in the natural disposition of the individual man, and determined by the occasions of his personal experience,—the 'active' reason, on the contrary, signifying the pure reason

1. *The Subnormal Mind*, London, 1935, p. 310.

2. *Sex and Repression in Savage Society*, London, 1927, p. VIII.

considered as unity in its nature and principles (*principielle Einheitlichkeit*), common to all individuals¹.

This distinction between the 'active' and 'passive' reason is full of meaning and pervades not only the psychology of Aristotle but also his ethics. From the modern psychological point of view, however, the vagueness which clouds the distinction as also the distinguished parts limits their importance here. The meaning of the 'active' or 'creative', reason and the 'passive', or receptive, reason is rather ambiguous and consequently possible interpretations are more than one.

Take first the 'active', or creative, reason. This reason it is to be noted, is immortal and thus entirely independent of the soul's union with body. It resembles in this respect Plato's rational soul. To this extent it is impersonal too. So far there seems to be no ambiguity. But here the question arises whether this 'active' reason is not personal in another sense. Let me elaborate this point a little, though it may involve some repetition. On the view of Aristotle what distinguishes the *human soul* from the *vegetative* and *animal souls* is this endowment of 'active' reason. In other words, every human being is human because it possesses the *human soul*, the *sine qua non* of which is the 'active', reason. That is to say, mankind 'as a whole' is to be distinguished from the vegetative-kind and the animal-kind, because every constituent of it is endowed with this faculty of 'active' reason. And I feel that there lurks an ambiguity about the adjunct 'universal' as qualifying 'active' reason. If it is understood as a distinguishing feature of 'mankind as a whole', the interpretation leaves full room to posit individual variability even with regard to this aspect of Reason. But in addition if we understand by it 'equal' distribution among all the constituents of humanity, we bring about a considerable change in the import the term 'active' reason. I am not very sure on this point, but it is the first of these interpretations which I feel inclined to follow. Nor am I very particular about being certain on this issue, because whatever the decision, psychologically it would not carry us any farther. For no interpretation would give us this 'active' reason in a pure psychological form stripped of everything mystical, or call it mythological. As Ward observes, this 'doctrine of active intellect is rather theological than psychological; it is in the main his philosophical version of the widely held belief of man's participation in the divine.'²

1. Windleband, *A History of Philosophy*, London, 1914, p. 150.

2. Ward, *Psychological Principles*, Cambridge, 1918, p. 14.

So far as I know, it is only Montmasson who has tried to look at this 'active' reason from the point of view of the unconscious. He brings this doctrine under the category of what he calls the *impersonal* or *metaphysical* unconscious.¹ Here again I do not find it very easy to understand him. If this doctrine of 'active' reason smacks of a theological tinge—and I think it does—it may be *impersonal* but it cannot be *metaphysical*, except by a very special restriction of the connotation of the term 'metaphysics' for which there seems to be no emergency. In the strict sense of the term 'metaphysics,' for anything to be 'impersonal' and 'metaphysical' are certainly compossible possibilities; but to say that because a certain thing possesses these two as compossible aspects, everything that comes under the one category can automatically be brought under the other is something which cannot easily be understood. Montmasson, however, has treated this point very summarily and to say anything more in this connection would be rather presumptuous on my part. Only I suggest that even on the distinction which Montmasson himself makes with regard to different opinions on the question of the nature of the unconscious he could have very rightly brought this doctrine of 'active' reason under the category of what he calls the *distant* or *palingenetic* unconscious. From the point of our distinction, I am not able to arrive at a final position as to the classification of this doctrine. The most I can say is that if this 'active', or 'creative', reason, is peculiar to each individual—and that is how I understand it—then it can partially be brought under the category of what we have called the Innate unconscious.²

Perhaps it is this Innate unconscious which dominates the great minds. Mind is the man after all. We do not get a Newton per apple that falls. Bathing was a matter of common practice but it needed Archimedes to enunciate the Law of Immersion. Thousands might have wept when Socrates drank hemlock, but *Fhaedo* is a legacy left by Plato alone. Even ordinary incidents and everyday occurrences are simply switched, and the world is enlightened on problems and riddles which may have baffled the human imagination for centuries: what matters is only the hand. And, I submit

1. *Invention and the Unconscious*, p. 10.

2. It will be observed that in explaining the Innate unconscious I have almost come to mean by it mental inheritance. And from this point of view I may be asked whether by classifying this 'active' reason as Innate unconscious, I suggest that the doctrine of heredity governs even the superhuman minds. I reply that the issue is too big for a short and definite opinion.

that it is the individual differences with regard to the endowment of this 'active' reason that holds the key to this magic.

But it is the 'passive' reason, we are told which forms the individuality of the individual. It constitutes 'the natural disposition of the individual man', determined by the occasions of his personal experience. If so, then on the distinction we have made, it should partly form the Innate unconscious and partly the Acquired.

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Here then I leave the Ancient Period, and before passing to the modern, it is worthwhile to cast a glance back. It cannot be denied that certain confusion mars almost all the interpretations which have been so far advanced. And with no effort is it possible to escape this situation of doubtful certainty. No thinker of this period enables us to draw what can be called a consistent and comprehensive theory of mind from the point of view of modern psychology. Socrates, Plato, and Aristotle are minds which can undoubtedly be counted among the greatest of any time in the world's history. But whatever may be the greatness of a genius, it has to live in time and move in space; and even supposing it succeeds in getting over its surrounding ties, it remains a fact that it has to elbow its way upwards through the forces around. Indeed, it is this ability more than anything else, which makes genius a genius. In Socrates we have a philosopher-saint, in Plato a poet-philosopher, in Aristotle a philosopher-scientist. No science begins as a science. A background is an essential pre-requisite and perhaps Plato needed Socrates, and Aristotle needed both. Though they have not given us a scientific theory of mind and its working the foundations they have laid are significant enough to make us realise the importance of the deeper recesses of mind which guide and control human activity in general to a considerable extent. And this contribution is undoubtedly substantial enough, for we must not forget that the period we have been surveying is far from being even the babyhood, much less the childhood, of scientific psychology. It marks only the period of its inception.

(To be continued)

G. K. SABNIS

“BOMBAY WORKERS OF UNTOUCHABLE CLASSES”

Introductory

“In characterising a Society whether ancient or modern there are two elements rather closely inter-connected which are of prime importance; one is the economic system and the other is the family system”.¹ In these words Mr. Bertrand Russell has given a very sound advice to a student of a social group. If sound and accurate conclusions are to be deduced, the data must not be purely sociological nor purely economic. These two factors, extensive as they are, and though separate they seem to be, are dependent on each other. The depressed Classes or the Backward Classes, as they are termed now, form a large portion of the Indian Population. In Bombay City 104,977² persons belong to the Depressed Classes. Of these 61,564 are males and 43,413³ are females. Their conditions are undergoing a radical change and hence it will not be out of place to hold a mirror up to show what they are both socially and economically at this juncture.

The Depressed Classes living in Bombay can be divided into two main sections on linguistic basis: the Marathi speaking and the Gujarati speaking. The Marathi speaking people come largely from Konkan and the Deccan Plateau. Of course there are some who come even from distant places like Nagpur and Berar. The Gujarati speaking people come from Gujarat, Kutch and Kathiawar. Even though these two units belong to the same religion still there is a great influence of the culture of the province they represent. Therefore if these two units are taken together, the conclusions would not be as specific as desired but of a general nature. On the other hand, if one homogeneous unit is taken the conclusions would be definite and useful. For example, there is such a great difference between the customs and manners and the ways of living including food and clothes between these two linguistically different societies,

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1. Bertrand Russell; “Marriage and Morals” Page 9.
 2. Census of India 1931 Vol. 9 Part 1. Page 42, Cities of the Bombay Presidency—Bombay.
 3. Ibid.

that it is necessary to use separate data for each unit to avoid creating a wrong impression about any group. It is a well-known fact that in India customs and manners and therefore social and economic conditions in different provinces are different and in a cosmopolitan City like Bombay these differences are no less observed. Under these circumstances, I propose to deal with the Gujarati speaking members of the Depressed Classes in Bombay.

To acquire sufficient data a questionnaire in Gujarati was printed and information was collected by going from door to door. The proportion of Schedules to be collected from one particular locality was not based on any hard and fast rule; but an attempt was made to visit almost all the centres where these people live to make the data as representative as possible. I visited the following 22 places and was able to get 634 schedules duly filled in :—

Statement No. 1

Centre	No. of Schedules
1. Annesly Road	... 22
2. Arthur Road	... 3
3. Bhendi Bazar	... 1
4. Byculla	... 19
5. Chinchpokly	... 4
6. Dadar Main Road	... 73
7. Dadar Ry. Quarters	... 4
8. Elphinstone Road	... 7
9. Girgaum	... 1
10. J. J. Hospital Quarters	... 5
11. Gunbow Street	... 1
12. Mogul Galli	... 8
13. Mhatar Pakhadi	... 11
14. Prabha Devi	... 45
15. Parel—Poibvadi	... 31
16. Sukhlaji Street	... 46
17. Tarvadi	... 77
18. Taikalwadi—Dadar	... 69
19. Umarkhadi	... 27
20. Wal Pakhadi	... 187
21. Worli	... 2
22. Wadi Bunder	... 1
	<hr/> 634 <hr/>

Of these 634 schedules the following classification can be made according to caste :—

Statement No. 2

1. Bhangis	...	265
2. Meghawals	...	309
3. Dheds	...	39
4. Chamars	...	21
		<hr/>
		634

Housing

These people are not given any particular corner of the City to live in but it could be seen from Statement No. 1 they are spread everywhere. During the course of my investigation I found the people of the same caste live together. For example, a Meghawal would live where Meghawals are living. The houses of the members of the Depressed Classes present a gloomy appearance. I do not know how their home can be the sphere of harmony and peace or it can be a paradise. To my mind for this the people are not to blame. In order to turn a verandah—if there is one—into a 'room' suitable to sleep in they put up gunny bags all around it, or to protect themselves from the sun and the rain they fix worn out pieces of gunnies or even of rags on their windows and doors, these pieces become extremely dirty and black on account of the fuel they use. These people generally use sawdust, dung-balls, rags, waste-papers and in a few cases inferior wood and very rarely coal as fuel. Naturally the room is full of smoke ; walls, roofs, pillars and in fact everything in the room becomes dark. One can imagine how much these people suffer from smoke nuisance. There is one thing which must be mentioned here. At night these people use kerosene tin-pots as lamps. These tinpots have no glass to serve as a chimney. Many people are in the habit of keeping these pots burning for the whole night. One can imagine how these people suffer from the injurious effects of the carbonic acid gas.

Generally each family has one room. This room is a kitchen, a sitting room, a sleeping room and a sick room. Even a married couple sleep in the same room with the other members. In some cases I was told if there are two or more married couples in the same room each couple takes advantage of the room by turns, or women sleeps in the room and men outside the room in the verandahs and arrange 'any how' for conjugal union. Even if

there are more than one couple sleeping in the same room they cannot afford to have and also they cannot have any partition between two couples sleeping there. Privacy which is so necessary for happy and successful conjugal relations is denied to them. One can imagine two married couples sleeping in the same room with children around them and among so many things—a 'zoli' or a cradle, cots and utensils. On account of insufficient space the natural sex functions of the married couples take place to the consciousness of all other members living in the room. It is not strange therefore that boys and girls of tender age exhibit sex tendencies earlier. 'Necessity is the mother of invention'. This rule holds good in case of some of these people as well. To accommodate more than one couple in the same room a very high cot or a platform is used. Upon this sleeps one couple and beneath it another couple. This ingenious devise is made use of also for other aspects of life.

All the families do not live in buildings constructed by the Bombay Development Department or the Bombay Municipality. There are many among them who live in huts made of 'zaolis' or of tin pieces of kerosene oil cases. For example at Taikalwadi Dadar Municipal employees have erected tin sheds or huts of 'zaolis' for them to live in.

Some of these people live in the worst possible localities. For example the Municipal Quarters on Sukhalaji Street are situated in a locality where prostitution of the lowest grade is going on. Here I have no intention of entering into the question of prostitution as an institution, but wish to point out its consequences as far as they pertain to these people. The people whose social and economic condition I am discussing are very poor; they never can make both ends of their family budget meet; they never have the satisfaction of a full belly and cannot wear sufficient clothes. It is no wonder therefore that young girls of these Classes are easily seduced or attracted to this profession. Quarters for poor people in such localities is to my mind highly injurious to their morality.

The following statements will show how these people live. They live in different kinds of tenements. No one of them of course has the satisfaction of living in a block or a flat. The very few people living in three or four room tenements do not live in good buildings but in the same locality among their fellowmen. It will be noticed that some families share one room in two different families, while in a majority of cases families live in single room tenements,

Statement No. 3

No. of Rooms in Tenements.	Total No. of Rooms required.	Total No. of families living.
$\frac{1}{2}$	8	16
1	596	596
2	40	20
3	3	1
4	4	1
Total	651	634

From the above statement it would be seen that 634 families live in 651 rooms. It would be also seen that 2.5 per cent. families share one room between two different families. 94 per cent. families can use one room per family. 3.1 per cent. families live in double room tenements while only .2 per cent. families live in three and four room tenements. It would also be seen that each family hardly gets 1.03 room to live in. It would be seen from the statement No. 18 that the total strength of 634 families is 2942. This means that at an average 4.6 persons have one room to live in. The results mentioned above can be tabulated as under for comparing them with the Census report:—

Statement No. 4

No. of rooms in Tenements.	Percentage to the total No. of tenements (651).	Average No. of occupants per Room in each class of tenements.
$\frac{1}{2}$	2.5	4.3
1	94	4.7
2	3.1	4
3	.2	3.3
4	.2	3.8
5	Nil.	Nil.
6	"	"

The above results can be compared with the following Census Report¹ :—

No. of Rooms in Tenements.	Percentage of each class to the total Tenements.		Average No. of persons in each room.	
	1931	1921	1931	1921
1	81	70	4.01	4.03
2	11	14	2.51	2.11
3	3	7	2.01	1.60
4	2	4	1.70	1.30
5	1	3	1.50	1.06
6	2	3	...	...

1. Census of India Vol. ix part I

Cities of Bombay Presidency. Bombay p. 90 statement No. 21

It will be noticed by looking at the above two tables that there is great overcrowding in each room in case of the Depressed Classes. For 'overcrowding' it is not the number of rooms that matters but the size of rooms at the disposal of each family. In case of these people they get one room per family and it can be stated that the dimensions of the rooms except for the B.D.D. or B.I.T. Chawls, are 10' x 10'. One special feature I have marked in the Gujarati speaking Depressed Classes is that each family has a cot. In a normal family of these people living in one room tenements the chief things which can be seen are a cot, a cradle, a 'chula' some earthen pots for water, and copper utensils. Besides these there are many bottles on shelves and wooden boxes.

In private chawls water closets and water taps are quite insufficient. The Improvement Trust or the Development Department Chawls might have been provided with water closets and water taps in proportion to the rooms but in case of some people it is a wrong distribution. Especially when the number of people living per room is decidedly larger, these ought to be distributed on the basis of people living in that quarter. On account of rush and insufficiency of water closets and taps, there is no wonder if these centres are dirty and filthy. The corners in the chawls where the water closets and taps are constructed is the most dirty corner. Even many of the B.D.D. and Municipal Chawls are not free from this evil.

In some chawls I found that food is not cooked in the room but outside in the passage. In a way it is good as the room is free from smoke and heat, but cooking outside the rooms presents a gloomy spectacle. The passages of almost all the chawls are dark. Here women keep their chulas, when chulas are burning the passages are full of smoke and so the darkness is intensified. In this darkness so many chulas twinkle with the result that the long passage between two rows of rooms appears to be some devil's den rather than the residence of human beings. In this way even the small space which is available to everyone for relaxation is utilised. At night people sleep among chulas and ash. To add to this confusion some people have kept sheep and dogs!

Vital (Including Birth and Death).

The general tone of the health of the children of the Depressed Classes is far from satisfactory. This may be due to want of proper feeding, ignorance and poverty. In almost all the quarters I found hawkers with sweets for children, but these as is well-known are prepared and kept in a most unscientific and unhygienic condition. Sweets are full of street dust and flooded

with flies. Same is the case with sweet-meat shops in these localities. The following description of a village sweet-meat shop applies equally to the similar shops in these localities. "The shop window is a fond resort of flies, bees and red-whasps which hum about the place in large numbers, while dust from the wayside constantly settles upon the unscreened trays of sweet-meat placed prominently for show".¹ In both these cases the piece of cloth used to ward off flies is so dirty and greasy that it would convince anybody that it is not washed since it came out of a Mill! In some quarters I found hawkers sitting in chawls with mutton sticks but the meat was rotten. Again there are many hawkers who frequently visit these quarters with articles of food made of beef. These articles being very cheap children and elders alike flock to such hawkers. At Wal-Pakhadi I bought some 'cubbobs' (made from beef). They are so cheap that for one pice we can get two or three of them; but its smell on account of the inferior oil used to fry them was so nauseating that as soon as I took them near my nose to smell them than I threw them away. I was also surprised to see a long piece of 'tilli' (liver) of cow or ox given for a pice. In my Sunday rounds I saw women hawkers belonging to the Depressed Classes selling beef from door to door at two annas per pound. The way in which the meat was handled by the hawkers concerned was extremely shocking. From morning till night there is a regular parade of these hawkers in these quarters and to show love and affection parents buy these dirty things for their children. It may be even a general rule that scarcely there is a father or mother who does not give a pice or two to his or her children. In some quarters I found hawkers selling 'kanji' and curry. Generally half a tumbler of kanji is given for one pice and parents buy it for their babies. The pots containing 'kanji' are not covered and the remarks which I have made regarding sweetmeat can be applied here also. Children—grown up and babies—without any piece of cloth on their body, with such dirty things in their hands, given by their elders to eat, sit outside their 'houses' generally in groups talking, playing or eating in the yards which are quite dirty and filthy and absolutely in insanitary conditions.

Cough, cold, fever, rickets and dysentery seem to be the common diseases prevalent among the children of these Classes. In some cases bellies of the children appear like drums while in some cases quite reverse is the case. Itches are very common.

1. "The Problem of Rural Uplift in India" by Dr. M. B. Ahmed, Page 25.

On account of unsound health children always cry and are of an irritable nature. Children play in the filth and dust and are often seen playing by the side of water closets, water taps and gutters! Children like their elders have not sufficient clothes to wear and what scanty clothes they wear are worn out, torn and extremely dirty. But it may be pointed out that it is not a special feature of untouchables only. Even among the touchables as far as the children of the lower strata are concerned, this state of affairs does exist. This state is due to poverty and ignorance. School going children are comparatively cleaner thanks to some workers in the centres organised by institutions like the Young Men's Christian Association and the Hindu Sevak Samaj etc.

In the following statement children born to the head of a family are considered :—

Statement No. 5

Children Born.	Boys.	Girls.
2211	1169	1042

It would be seen that out of 1000 children born 528·72 are boys and 471·7 are girls. This means that for 1000 boys born 891·4 are girls and for 1000 girls born 1121·8 are boys.

The following statement will show the mortality among children :—

Statement No. 6

Children Born.	Living.	Dead.
2211	1456	755

The following statement will show death among boys :—

Statement No. 7

Born.	Living.	Dead.
1169	760	409

Death among girls:—

Statement No. 8

Born.	Living.	Dead.
1042	696	346

From the Statement No. 6 it is seen that death among children is 341·5 per one thousand children born which is indeed tragic. More than one third of the children born die and as

already said those that are living are far from satisfactory from the point of view of health. Statement No. 7 shows 349·8 per one thousand boys born die. In the same way the death of girls can be determined. Here one thing must be made clear i.e. generally the death rate is calculated on the basis of live births. But I was not able to follow this method because the people with whom I was dealing were not in a position to understand the difference between the death at birth and still-births. It would be seen from statements Nos. 9 and 12 that 21 boys and 11 girls died at birth, but they also include still-births. The people being very ignorant cannot understand the difference between these two different events. From the Statement No. 8 it is seen that death among girls is 322·1 per one thousand girls.

It would be thus seen that death rate among boys is higher than that among girls.

In the following statements death rates of boys dying at different ages are shown :—

Statement No. 9

Boys dying at Birth including still-births.

Born.	Dead.	Death rate per 1000.
1169	21	17·9

Statement No. 10

Boys dying within one year :—

Open to Risk.	Dead.	Death rate per 1000.
1148	164	142·8

Statement No. 11

Boys dying after one year of their life but before completing the 5th year.

Open to Risk.	Dead.	Death rate per 1000.
984	184	186·9

From the above three statements it would be seen that out of 1169 boys born 369 boys die before completing their 5th year. This means that 315·5 boys per 1000 boys die during the first five years of their life.

In the following statements death rates of girls dying at different ages are shown :—

Statement No. 12

Girls dying at Birth including still-birth.

Born.	Dead.	Death rate per 1000
1042	11	10.6

Statement No. 13

Girls dying within one year :—

Open to Risk.	Dead.	Death rate per 1000
1031	175	169.7

Statement No. 14

Girls dying after one year of their life but before completing the 5th year.

Open to Risk.	Dead.	Death rate per 1000
856	130	151.8

From the above statements it would be seen that out of 1042 girls born 316 die before completing their 5th year. This means that within first five years of life 303.2 girls in every 1000 die.

All the statements show that the death rate of boys at birth is larger than the corresponding death rate of girls. The death rate of girls dying within one year is much greater than the corresponding death rate of boys; while the death rate of boys dying after one year but before completing the 5th year is far greater than the corresponding death rate of girls. If the death rate of boys dying within first five years of life is considered, it would be seen that it is greater than the corresponding death rate of girls.

In the Gujarati speaking Depressed Classes confinement generally takes place in the Free Maternity Hospitals. From the following statement the percentage of women taking advantage of Maternity Homes can be seen :—

Statement No. 15

Confinement.			Total.
Home.	Hospital.	Home & Hospital.	
59	504	28	591

Information about confinements was gathered from 591 women and it would be seen from the above statement that nearly 10 per cent. of them do not take advantage of Hospitals while a large number of women—85·2 per cent. women take advantage of Free Maternity Hospitals. The number of women who occasionally take advantage of Maternity Hospitals is 4·8. The death rate of children at birth is much smaller is perhaps due to the fact that quite a large number of women take advantage of maternity hospitals. But once the women return home with their new born babies, the whole environment changes. They cannot have rest nor nourishing food, nay they cannot even get plenty of fresh air; with the result that children have to give a great toll. When babies suffer from any disease these people prefer sacred ash or black thread as a talisman to medicine and would consult 'Mantris' and astrologers rather than qualified medical men. If parents ever try to find the result of their children's diseases, instead of finding fault with them, they prefer to accuse their neighbours with witchcraft!

In case of 241 children I was able to trace the immediate cause of their death. In almost all cases fever was accompanied by cough. I was not able to classify different fevers. In the following statement under three broad heads the deaths of children are classified :—

Statement No. 16

Fever and Cough	Dysentery	Small-pox
190	33	18

78·8 Children die on account of fever and cough. 13·7 children die on account of dysentery. Many children die at the time of teething. At this they suffer from acute green diarrhoea. This is included under dysentery. 7·5 children die of small-pox.

Diseases and Cures

The general ailments of the Depressed Classes are fever, cold, cough etc. Hardly there is a house which is free from these. In addition to these there are the ailments of children. To my mind housing conditions are responsible for the different diseases always found in these people. In addition to this great factor, there is a great problem of food-stuffs. Generally the food-stuffs used by these people are devoid of any vitalising power. Men and women have to do 'hard labour' during the whole day and in turn they receive very low remuneration in which they have to manage all household affairs. Hardly there is a house where all the members are employed. Children cannot get milk which is necessary for healthy and sound growth. Instead of milk they

get dirty and unhealthy eatables from the street hawkers. It seems that even water is not freely used by these people. The next important factor is of clothes. Due to heavy work these men and women have to do there is much wear and tear to their clothes. They cannot afford to change their clothes after work, so clothes which are full of dirt and sweat are on their bodies for all the hours of the day. They are washed when they get a holiday. Under these circumstances they never feel fresh. Taking into consideration the glaring facts revealed in our survey of the 'Housing Conditions'—half a dozen persons living in a room of 10' x 10' and the use of tin-pot oil lamps which are highly injurious on account of the carbonic acid gas—there is no wonder if these people are unhealthy and susceptible to diseases.

In an attempt to see how these people face diseases I came to know many things which are worth considering seriously. I already mentioned in my discussion on 'Child Mortality' that these people prefer sacred ash or black magic thread to medicines and go to the quacks instead of to the qualified medical men. That these people cannot pay the bills of the Doctors is true. But that they do not take advantage of the free medical help in the way they should is also a fact; nor are they able to buy good patent medicines from chemists. Knowing this state of these people there are seen many quacks loitering in their localities. They (quacks) are good orators and carry with them attractive advertisements with the result that these men buy cheap 'medicines' from them. But the result is awfully bad. Because "What the ancients fabulously reported of Pandora's Box is strictly true of the Doctor's packet namely that it contains in it seeds and principles of diseases".¹ But like Defoe I am not inclined to attribute stupidity to these people because of their fondness for taking medicines from the quacks who are very sweet talkers and courteous in their manners. In addition to these street doctors, there are many quacks who open dispensaries in these localities and make a good living.

They cannot go to the qualified medical men because they cannot afford to pay their charges. But when they find that sacred ash or magic thread or even the guaranteed medicines of the quacks are of no avail, they go to the qualified men and it is generally too late by them. Any way taking into consideration the poisonous ingredients in medicines of the quacks one is tempted to conclude that the insistence on the sacred ash or magic thread is the lesser evil.

1. Description of a Quack Doctor by Daniel Defoe.

This leaves one to wonder why these people do not take advantage of the free hospitals and dispensaries. That they should take advantage of these is natural but they do not take advantage of these in the way they should is the grim reality. People are afraid of charitable dispensaries and hospitals. They unfortunately think that instead of getting cured they might die earlier if they go to the hospitals or take medicines from the free dispensaries. Besides this, people have other grievances which I shall discuss at length.

Generally the charitable dispensaries open at 8 a. m. and close at 11 a. m. but during these hours the workers—the poor people for whom the charitable dispensaries are chiefly meant—are away toiling for their bread. When they come home the free dispensaries are closed. Naturally they have to give to their suffering dependents some private medical help. If they can they go to the private certified medical practitioners, but generally they buy ague or cough mixtures or some such mixtures which are graphically described in their localities. These mixtures are supposed to cure any disease. If they buy patented mixtures, the evil will decidedly be a lesser one, but always these mixtures are prepared by quacks. A cursory glance in the localities where the workers live will convince any one of the vast amount of sale these mixtures have. These mixtures again are very cheap. People blindly trust their operations of eyes, nose and the like to these devils. I have seen a magic pain balm sold for two pice. The bottles of this pain balm were sold like hot cakes. About 100 bottles were sold in less than half an hour. I was greatly amused to see the quack telling people that he would pay Rs. 500 if the pain balm was proved to be ineffective ! Effective it was. No sooner I applied it to my forehead than it became tan in colour, the skin being burnt up. To come to my original argument these people on account of their attendance where they have to work and from their point of view the awkward hours of the dispensaries cannot take their advantage. Only the Mill workers from this point of view are better off. The dispensaries being in the Mill compound they can use them if they mean to. The Municipal workers told me their reasons for not taking advantage of the Municipal dispensaries. Their chief contention is that they have to attend to their duties at 7 a.m. while the dispensaries open at 8 a.m. To save six annas if they go to these dispensaries they lose their wages for the day.

But the greatest reason on account of which these people shun to go to these charitable dispensaries is worth giving attention

to. I have to give it out with a due sense of duty, or I would be failing in my responsibility of revealing their true conditions. With apologies and due respect to the medical profession, I have to say that these people are afraid of the doctors and nurses. It may be due to the fact that medical profession has become highly commercialised¹. I do not suggest that these people are neglected or are not properly taken care of. In India even educated people have a prejudice against hospitals—not to speak of public hospitals—and they go to them only as a last resort. It would be too much to expect of these people to take advantage of the free hospitals and dispensaries. They become afraid and nervous if anybody tells them to take advantage of the free medical help. They look upon doctors and nurses with awe and fear. They never feel free and open-hearted with them. Doctors and nurses to them are supernatural beings. People do want to be cured. They go to the hospitals with that hope. Doctors and nurses try their best to cure the patient. But they are devoid of one thing—soothing words—which is more than a balm to a patient. Doctors come, examine and go away; nurses come at the appointed time to give medicines etc. There is a clockwise routine. There is no exchange of sympathising words. The people being ignorant and poor misunderstand this attitude of the staff and come to the conclusion that they are neglected. Even when they go to the hospitals, not unfrequently they leave them before the disease is cured.

Much propaganda and agitation is necessary in this behalf to impress upon the minds of the people that doctors visit the charitable dispensaries and hospitals at great personal sacrifice to serve the humanity and therefore in no way people should distrust them. Also if our medical men soon recognise that their ignorant brethren look upon them with awe and fear and therefore there is a tendency to shun them it would be better. It is sweet words that attract these people towards the quacks. Once it is admitted that these people are ignorant the onus to save their lives lies on their more educated fellow-countrymen.

Family

The Industrial Revolution may have changed the outlook of family or inspired individualistic theory but as far as these people are concerned, it can be said that they have left their native homes in search of food and money in industrial centres. There is no serious change in the composition of family. It may be that a major brother or son leaves his native home and comes to city to

1. Population Problems—by E. B. Reuter Ph. D. Page 264.

earn and thus it may look that his family is a separate unit and the old family is broken, but it is not so. The ties still continue. The man who has come to a city sends money, cloth or any useful thing to his men living in his native place and makes it a point to go and live with his men at the cost even of his service ; or when he is out of employment goes to live with his men in his native country.

The majority of the families of the Gujarati speaking Depressed Classes in Bombay are limited families no doubt. They are limited in a sense that they consist of man, wife and children. The statement No. 17 will show that there is a good number of families in which besides man, women and their children relations from the wife's or husband's side live. It would be noticed from the same statement that six men live singly and still each of them is supposed to have formed a family. I have regarded each of them to have formed family because many of them are married and have rooms to live in but their wives are out of Bombay and those who are not married have rooms to live in and cook their own food.

The following statement shows the different compositions of families :—

Statement No. 17

COMPOSITION OF FAMILIES

Adults.	Number of Children											Total
	0	1	2	3	4	5	6	7	8	9	10	
1 Man	6	0	0	4	2	1	0	0	0	0	0	13
1 m and 1 w	64	110	91	85	39	25	14	4	1	1	1	435
1 m and 2 w	12	20	24	18	11	4	1	0	0	0	0	90
1 m and 3 w	0	4	0	1	1	2	0	0	0	0	0	8
2 m	0	1	1	0	0	0	0	0	0	0	0	2
2 m and 1 w	11	10	4	8	1	0	1	0	0	0	0	35
2 m and 2 w	2	3	7	1	1	7	2	0	0	0	0	23
2 m and 3 w	0	2	2	3	2	0	0	0	0	0	0	9
2 m and 4 w	0	1	0	0	0	0	0	0	0	0	0	1
3 m	0	0	0	0	1	0	0	0	0	0	0	1
3 m and 2 w	2	2	0	1	1	1	0	0	0	0	0	7
3 m and 3 w	1	0	0	3	2	0	0	0	0	0	0	6
3 m and 4 w	0	0	1	0	0	0	0	0	0	0	0	1
4 m and 2 w	0	0	0	0	0	1	0	0	0	0	0	1
4 m and 4 w	0	0	0	0	0	0	0	1	0	0	0	1
6 m	1	0	0	0	0	0	0	0	0	0	0	1
Total	99	153	130	124	61	41	18	5	1	1	1	634

It would be seen from the above statement that a normal family consists of 1 man, 1 woman and children as the number of Schedules under that head is 435 or 68·6 per cent. of the total number of Schedules. With the help of the above statement following classification can be made:—

Statement No. 18

Distribution of men, women and children.			
Men.	Women.	Children.	Total.
745	793	1404	2942

This means that each family consists of 4·6 persons and in each family there are 1·2 men, 1·2 women and 2·2 children.

Marriage

From the following statement it would be seen that a greater percentage of the principal heads of families is married:—

Statement No. 19

Married.			
612			
Unmarried.	Married once.	Married more than once.	Total.
22	506	106	634

It would be seen that 96·5 per cent. men are married and only 3·5 men are unmarried. As for the age at marriage it is not fixed and man can get married whenever and as many times as he likes, but in case of minors it depends upon the caprice of the guardians. School going boys, if they oppose their parents in getting married, have to suffer great rebuke at the hands of the latter but those who do not go to Schools do not oppose their parents, rather on account of the peculiar conscience created in them that it is the bloom of all men's happiness are too eager to catch the opportunity of getting married.

The following statement would show the first and subsequent marriages:—

Statement No. 20.

506 Married once.
97 Married twice.
5 Married thrice.
1 Married 4 times.
2 Married 5 times.
1 Married 8 times.

612

From the above statement it would be seen that 17·3 per cent. married men are married more than once. Reasons for getting married more than once are many. All those who married thrice, four times, five times and eight times did so because their former wives were dead. In case of 97 men married twice it was found that 68 married for the second time because their first wives were dead and of the remaining 29 men 19 married for the second time even though their first wife was living because they did not have children by the first marriage and the remaining 10 married only out of pleasure.

Generally the first marriage of a man is with a virgin but subsequent marriages are with widows. Only in case of the man who has married eight times had his four marriages with virgins and four with widows. Before discussing the reasons why a widow is preferred in second and subsequent marriages, it will not be out of place to see the circumstances under which the second marriage takes place. It is already noted that death of the first wife is the chief and the foremost excuse for a man to get married a second time. If a man does not get a child some years after marriage, he comes to the conclusion that his wife cannot bear children and therefore marries a second time. When asked as to why they did not wait longer to see if the first wife would bear a child or not their reply was that there was no guarantee that passage of further time would make their wives bear a child, though it was noticed in some cases that the first wife did have children after her husband's second marriage. There are some cases where a man thinks it to be an honour to have more than one wife.

Generally a girl is 10 or 12 years old in her first marriage and a boy is 15 to 17 years old. Widows being older than virgins in age man prefers the former with a view to begin marital pleasures immediately after marriage.

634 Principal heads of the families had 737 wives, of the 634 men 612 are married. From this it would be seen that each married man has 1·2 wives. Of the 737 wives 615 are married once, 122 married more than once. It would be seen that 83·5 women marry once while 16·5 per cent. women marry more than once (not to mention some third or even fourth marriage).

It is already stated that girls and boys are married when they are too young. But though they are married rather young, they are conscious of their relations with each other. To this is added the instigations of the neighbours, friends and other relations. Women generally ask a young wife whether she had slept with

her husband and so forth. Graphic and realistically sensuous descriptions are made before her. The boy in his circle has the same experiences. Naturally with or without the consent of the guardian, the young couple leads a married life. Marriage being too early prepuberty intercourse is not uncommon, the housing conditions helping early sexuality.

The chief items of expenditure are dowry and caste-dinners. A bride-groom has to pay dowry to a bride or her guardian. Dowry is not fixed. It depends upon the circumstances and varies accordingly. If the people on the bridegroom's side like the girl very much and the people on the bride's side know this fact, then they demand a good dowry. Always the scale of the dowry in the first marriage—first marriage of a woman—is larger than in subsequent marriages. During the marriage festival there are about two or three dinners in honour of the marriage, given to the people of the community. Generally dinner contains some sweet dishes and in addition sometimes a goat is killed. Liquor is freely made use of. To this dinner relations, friends, and neighbours are invited.

I was able to collect some figures of marriage expenses for a single marriage. The following statement shows the amount spent by each family.

<i>Amount Rs.</i>	<i>Cases.</i>
150	5
200	75
250	84
300	57
350	5
400	34
425	13
500	204
550	15
600	43
650	4
700	12
900	1
1,000	2
1,200	1
	<hr/> 555 <hr/>

Thus it would be seen that Rs. 2,24,865/- are spent for 55 marriages which means that for one single marriage Rs. 405·1 are spent on an average.

Fertility

It would be seen from the statement No. 19 that out of 634 heads of families 22 are unmarried, and 612 are married, out of whom 58 have no children. Therefore, 2211 children born as shown in the statement No. 5 are born of 554 persons.

Statement No. 21

Men.	Children Born.	Children Born per Man.
554	2211	3.99

Thus it is seen that each man on an average has 4 children. Again if the average number of children born per each married man is to be determined then 2211 children born would be considered to have been born of 612 men. This means that 3.6 children are born per each married man.

The following statement would show different groups of women according to the number of children born to them.

Statement No. 22

No. of Children.	Cases.	Percentage of Women.
1	87	18.5
2	84	17.7
3	69	14.7
4	56	11.9
5	63	13.5
6	42	8.9
7	21	4.4
8	21	4.4
9	11	...
10	8	...
11	2	...
12	1	...
13	3	...

To find out an average number of children born to a woman only such women were selected in whose case the number of children born to them was definitely known and were considered in the above statement. Such women were 468 and the total number of children born to them was 1820. It is already seen in the above statement that one or two children per women is too

common an occurrence. An average of children born to each woman can be determined from the following statement :—

Statement No. 23

Cases.	No. of Children.	Average No. of children per woman.
468	1820	3·88

So it is seen that there is not much difference between the average number of children born to a man and to a woman.

Economic

It is already seen in the statement No. 18 that there are 745 men 793 women and 1404 children. The following is the classification of the adult earners :—

Statement No. 24

(P—Principal Earner. M—Male Earner other than P.
W—Woman Earner).

Earners.	Cases.	Men.	Women.
P	214	214	...
P & W	365	365	365
P & M	29	58	...
P, W and M	14	28	14
P and 2 M	6	18	...
P, 2 M and W	2	6	2
P, M and 2 W	1	2	2
P, 3 M and W	1	4	1
P and 2 W	2	2	4
	634	697	388

Out of 745 men 697 and out of 793 women 388 are employed. This means 92·2 per cent. men and 49·5 women are employed. The small percentage of unemployed may not necessarily be taken to mean that there is very little unemployment for these men are migrators from outside Bombay and when they are unemployed, they do not stay in the City but go to their native places. Again they are not employed to do any skilled labour but the work entrusted to them is of the lowest order. It would be seen from Statement No. 25 that majority of them are employed in the Municipality as scavengers or 'Halalkhores'. As this work is supposed to be done only by the people from a particular class or community there is no fear of any competition from others. As the Health Department of the Bombay Municipality requires

women workers, many of them have found employment in it. Nearly 50·5 per cent. women are unemployed. The cause of lesser unemployment both among men and women is also due to the fact that there is a great demand for these people of both sexes in different offices, schools and private buildings as scavengers etc.

The following statement will show where Principal earners are employed according to their employers :—

Statement No. 25

(A).

Employers.	Cases.	Percentage to the total.
Municipality	517	81·5
Mills	35	5·5
Railways	26	4·1
Private Bldgs.	20	3·1
Offices, shops &c.	15	2·5
Police (Quarters)	6	...
Hospital	5	...
Docks	5	...
Jail	1	...
Total	630	

(B).

Principal earners whose nature of employment is different :—

Private Motor		
Driver.	1	...
Second-hand Article		
Dealer.	3	...
Grand Total	634	

It can be seen from the above statement that 81·5 Principal earners are employed in the Municipality where except 10 all are scavengers. The nature of the work of these 10 is as follows :—

Teachers	4
Painters	2
Fitters	2
Carpenter	1
Peon	1
	<hr/> 10

Principal earners employed in Mills, Railways and private buildings, hospitals, Police quarters etc. are all scavengers. Out of 15 principal earners employed in offices, shops &c. one is a

clerk and another is an office boy while the remaining 13 are scavengers.

It would be thus seen that out of 634 principal earners only 15 earners or 2·3 per cent. of the total do that sort of work in which there is fear of competition from other castes while 619 earners are scavengers in public or private bodies. It also shows that the occupation of the people is almost entirely their traditional one.

Besides the heads of the families, as Principal earners, there are 63 other male earners who contribute to the income of the family. That is 9 man besides the principal earner contributes to the income of the family. The nature of the work of these 63 men is as follows :—

Municipality	39	61·9 P. C.
Private	11	17·4
Railways	7	11·1
Mills	5	7·8
Docks	1	1·8
	<hr/> 63	<hr/> 100·0

Of these 61·9 per cent. men are employed in the Municipality so it may be inferred that a great majority of the earners in these classes are employed in the Municipality. Second important thing to be noted from the nature of the work of the principal earners and other earners of families is that a dependent earner generally follows the occupation of the principal one.

Out of 388 women earners the following classification can be made :—

Statement No. 26

Employers.	Cases.	Percentage to the total No.
Municipality	222	57·2
Private Buildings	132	34·2
Mills	22	5·7
Hospitals	8	2·6
Railways	4	1·3
	<hr/>	<hr/>
Total :	388	100·0
	<hr/>	<hr/>

It may be mentioned here also that all the women earners are scavengers. It will be noticed that 57·2 per cent. of the total employed women are employed in the Municipality.

Earnings

The following statement will show the groups of principal earners according to their earnings :—

Statement No. 27

Rupees.	Principal Earners.	Percentage of the total.
0-10	4	...
11-15	15	2·3
16-20	102	16·1
21-25	445	70·1
26-30	45	7·1
31-35	8	...
36-40	6	...
41-45	2	...
46-50	3	...
51	1	...
75	1	...
80	1	...
100	1	...
	<hr/> 634	

It would be seen from the above statement that the majority of the principal earners earn something between 21 and 25. Principal earners earning more than Rs. 40 are not even half per cent. while those earning more than Rs. 50 are very rare. In the above statement there are 4 persons getting Rs. 75, 80 and 100 each. These 4 earners are teachers.

The earnings of all heads come to Rs. 14,075. This means that the average income per head of the family is Rs. 22·2.

In the following statement families are classified according to the total earnings :—

Statement No. 28

Rupees.	Cases.	Percentage to the total families.
15-20	45	7.2
21-25	175	27.6
26-30	123	19.4
31-35	68	10.7
36-40	62	9.8
41-45	44	6.9
46-50	79	12.4
51-55	10	...
56-60	6	...
61	1	...
66-70	8	...
71-75	3	...
80	1	...
81-85	2	...
86-90	2	...
96-100	4	...
120	1	...

634

The above statement would show the gross income of each family. It would be seen that the majority of families get from Rs. 21 and 30 each. The total income of the families is Rs. 22,076. This means that on an average the total income of each family is Rs. 34.8. Thus it would be seen that the average income of each head of the family is supplemented by Rs. 12.6.

Food

Generally food of these people consists of rice, bread and curry. In the morning tea is prepared at home or each member goes to a hotel and takes it there. I have seen some families using different kinds of vegetables. Beef is preferred to mutton by some, perhaps due to the fact that the former is cheaper. Some people cook only rice and buy curry from hotels or hawkers. Majority of them being scavengers, some of them eat the remains of food stuff thrown away or handed over to them by the people. To my query as to how some of them manage with such small expense on food, I got the reply that they sometimes begged for

food. Some of them even eat the remains of others' meal. In the following statement different sums of money spent on food are shown :—

Statement No. 29

No. of persons. ¹	Expense on Food per month.	No. of Families.	Total Income.	Total expenditure on Food.	Average p. c. on Food.
252·5	Below 15	101	2713·5	1403	50·1
459·5	16—20	149	4528·5	1944	42·9
426·5	21—25	123	3682·5	2852	77·4
581	26—30	157	5867	4686	79·9
88	31—35	20	885	696	78·5
131	36—40	29	1315	1139	86·6
100	41—45	20	895	900	100·5
115	46—50	21	920·5	1050	114·05
10·5	51—55	2	48	110	227·08
46·5	56—60	8	796	480	60·3
21·5	70	3	250	210	84
8	90	1	175	90	51·4
2240		634	22076	15560	

The actual expense on food of 634 families is Rs. 15,560. This means each family on an average spends Rs. 24·5 p. m. for the food and Rs. 6·9 p. m. per adult.

Clothes

Men's clothes consist of a dhoti, a shirt and a turban. Instead of dhoti and turban, some use pyjamas and cap. Young men use coats also. Boys are generally naked but they have a shirt to wear. Girls wear a ghagra or a skirt. Women wear a ghagra upon which they use a cloth 3 to 5 yards long to serve the purpose of a saree. For the upper body they use a bodice which covers only the chest while the back is exposed. There is one peculiarity about the dress of ladies. Even though it is cheap still it is very smart and brilliant in colour. Some people have cotton mattresses. Majority of them have Rajais made from torn and discarded clothes. Coarse blankets and very ordinary bed sheets are also used.

1. Two children are treated equal to an adult.

The following is the average annual expense per family on clothes :—

Annual Expense on clothes.	No. of families.
12	261
18	26
24	222
30	42
36	52
48	12
60	15
120	3
180	1
	— —
	634

The total expenses on clothes are Rs. 14,076 ; this means the total expense per family is on an average Rs. 22·2 per annum or Rupee ·5 per annum per adult.

Rent

As I could not get trustworthy figures of rent I am unable to write on it at present.

Vice

1. Country Liquor and Toddy are the favourite drinks of these people. Now-a-days there is a tendency also to take Beer. Out of 634 principal heads one is in habit of taking opium. He also smokes Ganja. Of the remaining 633 men 406 flatly denied having taken liquor. Out of the remaining 227 men 66 admitted that they sometimes, especially when they attend any marriage or funeral, take liquor. While 161 men said that they take liquor every day. Thus it would be seen that 35·9 p. c. men of the total principal heads of families take liquor. Of those who take liquor 70·2 p. c. take it always.

2. Cotton futures is a second great drain upon the scanty purse of these people. Here it was not possible for me to collect figures of those who back the Cotton figures and of those who do not. I had to rely solely on my eyes and ears. I saw even women consulting "Cotton Experts" about the Opening and Closing rates of New York Market ! In these localities one pice news-papers which chiefly deal in cotton figures, have a great sale. Again there are pan-shops

or boys selling sealed envelopes containing the figures to be backed that day. These envelopes are sold from one pice to 4 annas. There are seen odd men and women or loafers surrounded by many people, among whom are these people, eagerly waiting for the man or woman to give out a figure. Madness or any oddity is associated with the power to know the future! The scandal of 'Satta-Khel' has reached the children of tender age. I was able to gather from some of these people that they play with 4 annas; and those who are not able to spare 4 annas share with somebody else.

Indebtedness

Marriage and death are the two occasions when these people have to incur debts because they have to give caste-dinners. Marwadis, Pathans, Baniyas and Bhayyas are the chief creditors. Especially the first three do brisk business among these people. In my investigation I found that there are eight persons of the Bhangi community who lend money at the same rates as the Pathans' and Marwadis'. There is also one Christian Money-lender. I was surprised to see that out of 634 heads of the families only two admitted to have borrowed money from the Municipal Employees Co-operative Credit Societies. The Pathans charge the highest rate of interest—4 annas per Rupee per month—the rate comes to 300 per cent. per annum. The Marwadis charge 2 annas per rupee per month or 150 p. c. per annum. The Baniyas generally charge one anna per rupee per month or 75 p. c. per annum. Always the interest of every month is paid in advance. The creditors do not care for the capital. The Pathans say "Let the capital go to hell, I want the interest". There are some families in whose case even the month's earnings are not sufficient to pay off the interest. Such people hand-over all their earnings to the creditors. A man has more than one creditor. If the creditors harass very much then they frequently change quarters or even go to their native country. I have seen one thing that the Pathans and Marwadis are always eager to lend, thought not the full amount asked for. The Baniyas charge two annas per rupee per month for cash and one anna per rupee per month for the articles of food taken on credit. The cheapest rate of interest is 36% per annum.

Out of 634 principal heads of families only 15 have no debts while the remaining are in debts. Out of the debtors only two have borrowed money from the Municipal Employees Co-operative Credit Society.

The following 223 men revealed the amount of their debts :—

Total debts	Cases
Rs.	
50	1
100	13
150	1
200	38
250	2
300	25
350	5
400	36
450	2
500	67
550	2
600	6
650	1
700	7
800	7
1000	4
1200	1
1500	1
1800	2
2000	2
	<hr/>
	223

This means that the above 223 men have a debt of Rs. 98,600 which means each principal head of a family has a debt of Rs. 440·3 on an average. It is very difficult to give the rates of interest in each case as the money is not borrowed from one single creditor. A man has at least three creditors: Pathans, Marwaris and Banias. In addition to these, are the arrears in rent, milk, kerosene oil charges etc. The total debts mentioned above are the gross debts of each man.

GOPINATH R. PRADHAN.

(*To be continued*)

A SOCIAL AND ECONOMIC STUDY OF THE MUNICIPAL PRIMARY TEACHERS IN BOMBAY

This article is the result of a special investigation into the social and economic condition of the Primary Teachers in the City of Bombay working under the control of the Bombay Municipality. Forms of enquiry containing 16 queries relating to the various aspects of the economic and social condition of the teachers were printed in Marathi, Gujarati and Urdu, and teachers were persuaded to give answers to the queries. Out of 2014 Municipal Primary Teachers on all the three sides in March 1935, as many as 1164, that is 57 per cent. of them gave us the necessary data for our enquiry. The data we could acquire by visiting almost all the Municipal Schools and persuading teachers individually after strenuous efforts for eight months during the academic year 1934-35, is carefully analysed here.

At the outset the figures given in the following table are of interest :—

Table showing the distribution of Primary Teachers according to their groups, percentage of each group to the total number of teachers, proportion in which different groups stand to one another, and teachers from whom we have data for our enquiry, etc.

Groups of Teachers.	Total No. of teachers in the group.	Percentage of the group to the total No. of teachers.	Proportion in which the Nos. in groups stand to the one another	No. of teachers from whom we have data.	Percentage of teachers who have given data.
Marathi Male Teachers	847	42.1 p. c.	8.5	517	61 p. c.
Marathi Female Teachers	383	19.0 „	3.8	179	46.7 „
Gujerati Male Teachers	238	11.8 „	2.4	153	64.3 „
Gujerati Female Teachers	144	7.2 „	1.4	61	42.4 „
Urdu Male Teachers	241	11.9 „	2.4	153	63.5 „
Urdu Female Teachers	161	8.0 „	1.6	101	62.7 „
Total ...	2014			1164	57 p. c. (average)

The Marathi Male Teachers are the largest in number, whereas the Gujerati Female Teachers are the smallest in number, standing in the proportion of 8·5 : 1·4. Between the two extremes stand in a decreasing number Marathi Female Teachers, Urdu Male Teachers, Gujerati Male Teachers, and Urdu Female Teachers. Urdu Male Teachers and Gujerati Male Teachers are almost equal in number. The Marathi Male and Female Teachers together, are more than three times the total Gujerati Teachers together, or the total Urdu Teachers together. The Marathi Teachers are more than three-fifths of the total number of teachers, while the Gujerati and Urdu are each one-fifth of the total number of teachers.

We have data from 1164 out of 2014 Primary Teachers, that is from 57 per cent. of them. Thus there would be no hesitation to say that our enquiry on the whole is quite representative. It is in the light of this basic data that we take in this article a broad view of the socio-economic position of the Municipal Primary Teachers as one big class, at the same time differentiating between groups and groups wherever it is necessary in order to bring out the essential features of each group in a comparative way.

TEACHERS AND THEIR NATIVE PLACES

At the outset it will be interesting to see the various places from which the big class of Municipal Teachers is attracted to Bombay. 136 out of 1164 teachers, that is 11·7 per cent. of the total number of teachers belong to Bombay proper. But this number is constituted by Gujerati Female, Urdu Female, and Marathi Female teachers in a decreasing proportion. Hardly any of the male teachers belong to Bombay proper. The Ratnagiri district supplies 28·8 per cent. of the total number of teachers who are almost all of them Marathi Male Teachers and a few are Marathi Female Teachers. The small state of Sawantwadi supplies 2·1 per cent. of the teachers who are also Marathi speaking. The next important Marathi speaking district from which teachers have come to Bombay are Kolaba, Poona, Thana and Satara, each sending respectively 5·9 per cent., 5·9 per cent., 3·3 per cent., and 3·4 per cent. of the total number of teachers on the Marathi side. From among the districts of Gujerat, the leading districts are of Surat and Kheda, and the province of Kathiawar, each supplying 4·7 per cent. 3·8 per cent. and 2 per cent. of the total number of teachers respectively on the Gujerati side. There are about 12 per cent. of the total number of teachers who belong to various minor towns in the Bombay Presidency. They are 125 in number and it is interesting for us to note that they belong to all the six

groups of teachers in varying proportions. Thus there are 88 per cent. of the teachers who belong to the Bombay Presidency and the Indian States included in that Presidency.

There are some teachers who come from other parts of India. The United Provinces occupy a leading place from which 60 or 5·2 per cent. of the teachers come, and they are either Urdu Males or Females. About one per cent. of the teachers come from the Central Province and they are working either on the Urdu or Marathi side. There are a few teachers coming from the Punjab, Madras, Bengal, Delhi and N. W. Province, Hyderabad and Kashmere State etc., but they do not form any significant proportion in the big class of Primary Teachers, though they are distinctly marked on the Urdu side, both Males and Females.

We sum up these observations in the following table :—

Place of origin	No. of Teachers	Percentage to the Total	Group or groups in which distinctly marked
Bombay City ...	136	11·7 p. c.	Gujerati, Urdu, Marathi Female Teachers
Ratnagiri District (including Sawantwadi State)	360	30·9 p. c.	Marathi Male and Female Teachers
Kolaba ...	68	5·9 p. c.	do.
Poona ...	69	5·9 p. c.	do.
Satara and Thana ...	77	6·7 p. c.	do.
Surat ...	54	4·7 p. c.	Gujerati Male and Female Teachers
Kheda ...	44	3·8 p. c.	do.
Kathiawar ...	24	2·0 p. c.	do.
Ahmedabad ...	17	1·5 p. c.	do.
Other minor towns of Bombay Presidency	165	14·5 p. c.	All the six Groups
United Provinces ...	60	5·2 p. c.	Urdu Male and Female Teachers
Central Province ...	11	1·0 p. c.	Marathi Male and Urdu Male Teachers
Other parts of India	47	4·2 p. c.	Urdu male & Female Teachers
Not stated ...	32	2·8 p. c.	Marathi Female, Urdu Male and Female, and Gujarati Female Teachers.
Total ...	1164		

Urdu Teachers, both Males and Females, are drawn from every part of India. The position of the three groups of Female Teachers compares well as regards those who are drawn from the

city of Bombay proper. The position of Marathi and Gujarati Male Teachers is similar in each group being respectively drawn mainly from the Marathi speaking districts of Konkan and Deccan, and Gujarati speaking areas of Gujarat and Kathiawar.

The big group of Municipal Primary Teachers is mainly drawn from Ratnagiri district, other Marathi speaking districts of the Deccan, districts of Gujarat, the City of Bombay proper, and about one-tenth of the group is drawn from the remaining provinces of India, U. P. taking the lead.

THE FEMALE TEACHERS—THEIR DISTINGUISHING POSITION

For following in its proper perspective the discussion in this article, we like to point out one important fact that the socio-economic position of the Female Teachers is on the whole far better than that of the Male Teachers in general. This is mainly due to the fact that the burden of family responsibility is comparatively far less among Female Teachers. They therefore can afford to live a life becoming their social status by spending a proper or reasonable amount on house rent. Again, indebtedness is not so serious among them as among the Male Teachers. Some of them live with other male members who are also earning, so their economic position is satisfactory. The three groups of Female Teachers together consist of 688 teachers, their number being 34.2 per cent. of the total number of teachers. Thus a little more than one-third of the total number of teachers, enjoy the special position. We have the necessary data from 341 teachers out of 688 that is from 50 per cent. of the total number of female teachers.

AGE OF TEACHERS AND THEIR LENGTH OF SERVICE

The following table shows the distribution of teachers according to their age-groups and service-groups :—

Comparison of Age-Groups and Service-Groups.

<i>Age-Groups</i>			<i>Service-Groups</i>		
Age-Groups	Total No. of Teachers	Percentage included in the Group	Percentage included in the Group	Total No. of teachers	Service-Groups
(1)	(2)	(3)	(4)	(5)	(6)
Under 25 yrs	125	10.7	12.7	147	1 to 5 years
26 to 35 „	513	44.0	54.5	634	6 to 15 years
36 to 45 „	376	32.3	27.8	327	16 to 25 years
46 to 50 „	84	7.2	3.3	38	26 to 30 years
51 to 55 „	37	3.2	1.03	12	31 to 35 years
Not stated	29	2.5	0.4	6	Not stated
Total	1164			1164	

Percentages in the age-groups should be compared with the percentages in the service-groups as they are on the whole meant for the same number of years. There are 10·7 per cent. of the teachers in the age-group under 25, but there are 12·7 per cent. of the teachers who have served for 1 to 5 years. This means that 22 teachers or 2 per cent. of the teachers must have joined service when they were less than 20 years in age. This is due to the fact that there are some Urdu Female Teachers and a few of the Marathi Female Teachers who have joined service when they were below the age of 20.

The higher percentage of the teachers in the service-group of 6 to 15 years, than the percentage of teachers in the age-group of 26 to 35 years, is due to some of the teachers, especially Urdu and Marathi Female Teachers having joined service when they were below the age of 20.

But the percentages in the service-groups of 36 to 45 years, 46 to 50 years, and 51 to 55 years are lower than the corresponding percentages in the age-groups under 36 to 45, 46 to 50, and 51 to 55 years. The explanation is obvious. The effect of some of the Urdu Female Teachers, and a few of the Marathi Female Teachers having joined service when under the age of 20 years is marked on the percentages for the whole group of teachers upto 35 years or upto 15 years of their commencing service. But in later groups, this difference is not marked but it is rather noted the other way because of the very large number of teachers included in the class of Primary Teachers as a whole, and also due to comparatively greater expansion of Urdu and Marathi Girls' schools during the last 15 years, this having its effect on the last three percentage figures. The higher percentages of age-groups in the last three cases, from 36 to 55 years, are also due to some of the Gujerati Male and Gujerati Female Teachers having joined service when they were above 25 years in age.

TEACHERS AND THEIR EDUCATIONAL QUALIFICATIONS

As regards educational qualifications, 707 teachers out of 1164, or 60·8 per cent. of the total number of teachers are trained. But the percentage of the trained teachers is marked to the greatest extent among Gujerati Female Teachers as in that group we get 83 per cent. of the teachers as trained teachers. And the lowest number of trained teachers is to be found among Urdu Female Teachers, only 41 per cent. of them being trained. The percentage of trained teachers is not very encouraging among Gujerati Male Teachers as 54 per cent. of them are trained. Among

Marathi Male and Female Teachers the percentage of trained teachers is respectively 63 and 62.

Out of 1164 teachers, as many as 386, that is 33·2 per cent. of the total number of teachers have knowledge of English. But it is very discouraging to note that this percentage is very low among Urdu Female Teachers, it being only 6 per cent. At the same time it is highest among Gujerati Female Teachers, 47 per cent. of them having knowledge of English. The percentage of Gujerati Male Teachers having knowledge of English is also high being 43. This is possibly due to the business instinct of the community. 37 per cent. of the Marathi Male Teachers and 28 per cent. of the Marathi Female Teachers have knowledge of English.

Thus the Primary Teachers of Bombay are on the whole qualified for their profession. The group of Gujerati Female Teachers is the best qualified, whereas that of the Urdu Female Teachers does not come even upto the minimum requirements. The remaining four groups of teachers are almost on the same level with little differences. However to a close observer these things are visible—that the Marathi speaking people mainly drawn from the district of Ratnagiri, and districts of Kolaba, Poona, Satara and Thana, take themselves to this profession easily and somewhat instinctively. People coming from Surat, Kheda, and other parts of Gujerat have rather commercial and business instincts in them. The Gujerati speaking Female Teachers and especially the Parsee Females choose this profession due to their general progress. They do it to utilise their leisure with advantage unlike others who do it out of necessity. This is also the case with a few of the Marathi Female Teachers, especially those who happen to be the original residents of Bombay, and also females belonging to some of the communities like Prabhus, Saraswats and others.

TEACHERS—THEIR RELIGIONS AND CASTES

Turning to the religions and castes of the Primary Teachers, we find that the majority of them are Hindus. There are 830 Hindus out of 1164, that is 71·3 per cent. of the total number of teachers. The majority of the Hindu teachers belong to the advanced communities, but on the whole they are drawn from all the communities. It is interesting to note that in the three groups of Marathi Male, Gujerati Male, and Marathi Female Teachers we get in all 30 depressed class teachers. These three groups of teachers consist of Hindu teachers on the whole. Then we have 254 Mahomedans in the total number of 1164, that is 21·8 per cent. of the total number of teachers. The Urdu teachers are all of them

Mahomedans. The Parsees who are 32 in number, that is 2·7 per cent. of the total number of teachers, occupy a leading and foremost place only in the group of Gujarati Female Teachers. There are 20 teachers, that is 1·7 per cent. of the total number of teachers who are Indian Christians ; but all of them are found in the Marathi Male Teachers' group. The Jews who are 26 in number, or 2·2 per cent. of the total number of teachers, are all females in the Marathi Female group of teachers. There are only two Jains in the group of Gujarati Female Teachers.

Thus the Urdu groups belong to one religion only, namely the Mahomedan. The Gujarati Male Teachers' group consists of Hindus exclusively. The Gujarati Female group consists of Parsees, Hindus, Christians and Jains. The Marathi Male Teachers' group consists of Hindus, and of a very small percentage (2·5) of Indian Christians, while that of Marathi Female Teachers' consists of Hindus and 17 per cent. of Jews.

INCOME FROM SALARIES

The teachers' salary varies from Rs. 30 to Rs. 150 per month, but in 7 cases it is Rs. 152 and in one more case is Rs. 165. However it will be quite proper for us to divide the teachers in three groups as shown in the following table :—

Details of salary per month	Total No. of teachers	Percentage to the total No. of teachers (to 1164)
Rs. 31 to 60 ...	442	38 p. c.
Rs. 61 to 100 ...	419	36 p. c.
Rs. 101 to 150 ...	294	25·3 p. c.
—		
1155 ¹		

The table shows that in the case of 38 per cent. of the teachers, their salary is rather low. There is no help for it, the teachers being in the preliminary stage of their service the salaries are low. In the remaining 62 per cent. of the cases, salaries are on the whole satisfactory.

It is important to note that the percentage of teachers with salaries less than Rs. 60 is the largest in the Urdu group of Female Teachers, 78 per cent. of the teachers of that group earning that salary ; while the percentage is the smallest in the Gujarati group of Female Teachers, there being only 26 per cent. of the teachers in that group. In the former class the large percentage is due to a majority of untrained teachers, while in the latter group it is due to a minority of untrained teachers.

1. In one case the salary is not known. In 7 cases the salary is Rs. 152, and in one case it is Rs. 165. When these nine cases are added to 1155, the total comes to 1164.

There are 36 per cent. of the teachers earning a salary of Rs. 61 to 100, but their percentage is smallest in the group of Gujarati Female Teachers, it being only 21 per cent. It is highest in the group of Urdu Male Teachers, being 49 per cent.

Lastly, there are 25·3 per cent. of the teachers earning from Rs. 101 to 150. But their percentage is as high as 52 per cent. in the group of Gujarati Female Teachers, while it is zero in the case of the Urdu Female Teachers. This is obviously due to a very large percentage of trained teachers in the former group of teachers in service for a long number of years, while their very small proportion and that also for the last ten years in the latter group.

INCOME FROM OTHER SOURCES

As regards income from other sources we shall first consider income from some other regular work apart from service. There is no harm to generalise that at least 20 per cent. of the Male Teachers on all the three sides earn some income from tuitions for about six months of the year. For various reasons we could not get actual particulars from every teacher on this point. In the Marathi Male group there are only 6 per cent of the teachers while in the Gujarati Male group there are 8 per cent. of the teachers who have stated that they earn income from other sources. Apart from tuitions some of these teachers are doing business as insurance agents or watch-repairers or physicians.

We now consider income from land. There are only 185 teachers out of 1164,¹ that is 16 per cent. of the total number of teachers who have got land. This percentage is very small. We briefly analyse these 185 cases of income from land. In 28 cases out of 185, the land does not bring any income to its holders on account of recent economic depression. That is in the case of 15 per cent. of the teachers who have got land, their land does not bring them any income. It is important to note that the majority of these cases, 20 out of 28, are from Marathi Male Teachers, 61 per cent. of that group of teachers coming from Ratnagiri and Savantwadi, where the position of landed income is generally very poor as compared to any other parts from which teachers come. In the remaining 157 cases out of 185, the income from land varies from Rs. 5 to Rs. 400 per year. These cases include two

1. Out of 1164, there are 341 Female Teachers belonging to the Marathi, Gujarati and Urdu groups. In the case of Females, ownership of land is a rare thing as compared to males for various reasons. There are only 11 female teachers who have got land. Two of them are from Gujarati group, while the remaining 9 are from the Marathi group.

cases which are exceptionally good, the income being Rs. 1,000 and Rs. 2,100 ; and 15 more cases in which income is stated in kind varying from 5 maunds to 3 Khandis per year. The following table shows the analysis of 140 cases of income from land :—

Details of income per year.		Total No. of cases.
From Rs. 5 to Rs. 30	...	58
„ Rs. 31 to Rs. 100	...	66
„ Rs. 101 to Rs. 200	...	12
„ Rs. 201 to Rs. 300	...	2
„ Rs. 301 to Rs. 400	...	2
		<hr/>
	Total	140

Some of the teachers have got very low income from land. However teachers who have got land have a good asset with them in times of difficulties or as a means of spending time in long holidays or after retirement from service.

A few further observations are necessary. From the group of Marathi Male Teachers, 29·2 per cent. possess land. But as 61 per cent. of the Marathi Male Teachers come from the district of Ratnagiri including Savantwadi State where the land values are low owing to fragmentation and sub-division of holdings, and the inferiority of the soil in point of fertility, the position of those who hold land is not very encouraging. In many cases the income from land is so low as is hardly enough to pay the land revenue, and in some cases the owners of land have to spend from other sources in order to pay the land revenue. In the Ratnagiri district in a majority of cases the possession of land is not a very tempting asset. The position is relatively better in Kolaba, Satara and Poona. Though 29·2 per cent. of the Marathi Male Teachers hold land, in many cases the income from land is nominal, in some cases the amount of income varies from Rs. 5 to Rs. 100 per year, or to Rs. 150 per year in a very few cases. The position of Gujarati Male Teachers as regards income from land is better when compared to that of Marathi Male Teachers, owing to the fact that the nature of lands in Gujarat is far better in point of fertility, and the average size of holding is generally larger as compared to the size of landed holdings in the Marathi speaking districts.

EXPENDITURE ON RENT

The economic condition of teachers and their social status can be understood to a certain extent in the light of their expenditure

on rent. The following table shows the amount of expenditure on rent per month of the Primary Teachers :—

Details of rent per month	No. of teachers	Percentage to the total
Upto Rs. 5 ...	35	3·0 p. c.
Rs. 6 to 10 ...	258	22·2 p. c.
Rs. 11 to 15 ...	346	29·7 p. c.
Rs. 16 to 25 ...	406	35·0 p. c.
Rs. 26 to 35 ...	56	4·8 p. c.
Above Rs. 36 ...	28	2·4 p. c.
Not stated ...	31	
Nil ...	4	
Total 1164		

A monthly rent of less than Rs. 10 per month is undoubtedly very low and indicative of inadequate and insanitary housing condition in a City like Bombay. However we must take allowance for such cases where rent is paid in partnership. There are 25·2 per cent. of the teachers paying rent less than Rs. 10 per month. On a liberal estimate, one-third of these teachers may be paying rent in partnership. Still we have about 17 per cent. of the teachers whose housing condition is bad due to very low rent that they pay.

There are 29·7 per cent. of the teachers who pay rent varying from Rs. 11 to 15 per month. In case the family consists of three members, the housing accommodation is likely to be satisfactory. But in case of families larger than that, the room that can be had within Rs. 15 is sure to be unsatisfactory. There is no harm in saying that in about half of these cases, owing to big families the room is sure to be inadequate and unhygienic. We can thus estimate that the housing condition is not satisfactory among 15 per cent. of the total number of teachers. These cases are distributed among those who spend from Rs. 11 to 15 as rent per month.

There are 35 per cent. of the teachers spending from Rs. 16 to 25 per month on house rent. But in this group there are more than two-thirds of the cases of those teachers who spend less than Rs. 20 per month on rent. The housing condition of teachers in this group is expected to be adequate and satisfactory except in those cases where the family is large consisting of six or more members. We estimate that out of 35 per cent. of the cases, in about 15 per cent. the housing accommodation is bad due to the large number of dependents.

The condition of those who spend more than Rs. 25 per month on house rent is likley to be satisfactory. But there are only 7·2 per cent. of the total number of teachers in this group.

The above analysis reveals to us that in case of about 47 per cent. of the total number of teachers, the kind of housing accommodation that they can afford to have in this city is unsatisfactory from considerations of adequacy and sanitation. This is but natural when we remember that in the case of 38 per cent. of the total number of teachers salaries are low being less than Rs. 60 per month.

A few comparative figures are necessary on this point. There is the largest proportion of teachers on the Urdu side of those who spend from Rs. 6 to 10 per month on house rent. 43·2 per cent. of the Urdu Male Teachers, and 35 per cent. of the Urdu Female Teachers pay such a low rent. It indicates their general social backwardness. There are only 5 per cent. of the Gujarati Female Teachers who spend such a low rent, while their percentage among Marathi Female Teachers is 6·7. The percentages for Marathi and Gujarati Male Teachers are respectively 23 and 15.

In the group of Teachers who spend from Rs. 11 to 15 on house rent per month, the percentage of Marathi Male Teachers is largest being 34, while that of the Gujarati Female Teachers is lowest being only 8. That the Marathi Male Teachers are on a quite ordinary level is clear from this percentage.

In the case of rent varying from Rs. 16 to 25 per month, the position of Gujarati Female Teachers is the best as 46 per cent. of them pay this rent. The Urdu Male Teachers stand last, their percentage being 26·5.

As regards rent above Rs. 26 per month, the position of Gujarati Female Teachers is the best, their percentage of those who pay this rent being 7. But only 2·7 per cent. of the Marathi Male Teachers spend this rent. The position of Urdu Male and Female Teachers is very bad, their percentage of those who pay so much rent being only 2 and 1 respectively.

Considering monthly rent above Rs. 16 as indicative of a fair social and economic status, the six groups of teachers stand in a descending order thus :—Gujarati Female Teachers, Marathi Female Teachers, Gujarati Male Teachers, Marathi Male Teachers, Urdu Female Teachers, and Urdu Male Teachers.

Considering all the teachers as one class, the housing accommodation as indicated by rent seems to be unsatisfactory in about 47 per cent. of them.

FAMILY RESPONSIBILITY

The economic condition of teachers can be further understood in the light of the burden of family responsibility which they have got to bear. The following table showing the number of dependents per teacher is significant in this connection:—

Details of dependents	No. of teachers	Percentage to the total
Nil	14	...
1 to 3	191	16·4 p. c.
4 to 6	622	53·5 p. c.
7 to 10	267	23·0 p. c.
11 and above	50	4·3 p. c.
Not stated	20	
<hr/>		
Total	1164	

There are 14 teachers who have got no one as dependent upon them. They are all female teachers. In case of 16·4 per cent. of the teachers who have to support from 1 to 3 dependents, family responsibility can be said to be moderate. More than half of the total number of teachers, have got to support from 4 to 6 dependents. Family responsibility may be normal in the case of those who have got a monthly salary of Rs. 80 or above, but in the case of those teachers who earn less than Rs. 80 per month, family responsibility can be said to be rather heavy. Roughly we can estimate that out of such 53·5 per cent. of the teachers, at least in case of 25 per cent. of them it is likely that family responsibility may be rather heavy due to low salaries.

There are 23 per cent. of the total number of teachers who have got to support from 7 to 10 dependents. The burden of family responsibility is abnormally heavy in the case of these 23 per cent. of the teachers as they have to support dependents varying from 7 to 10 in number.

Lastly in the case of 4·3 per cent. of the total number of teachers who have got to support a family consisting of more than 11 members, it is quite obvious that the burden of family responsibility is extremely heavy.

We have thus in all 52·3 per cent. of the total number of teachers bearing a heavy burden of family responsibility.

Some comparative figures are necessary on this point. We have 16·4 per cent. of the total number of teachers supporting dependents from 1 to 3. But it is very significant to note that this percentage is the highest in the group of Marathi Female Teachers,

there being 39·6 per cent. of them in that group. In the group of Gujarati Female Teachers that percentage is 24·5. But in the group of Urdu Female Teachers it is about 19, and it is lowest among Urdu Male Teachers being 7·8. The corresponding percentages in the groups of Gujarati Male Teachers and Marathi Male Teachers are 13·7 and 10·2 respectively. These percentages indicate the average large size of a family among Urdu teachers, and a small family among Marathi Female Teachers.

There are 53·5 per cent. of the total number of teachers maintaining a family of 4 to 6 dependents. It is interesting to note that this percentage is almost the same for the different groups of teachers except the group of Marathi Female Teachers in whose case the percentage is 43·6. This low percentage in the Marathi Female group of teachers is due to their very large percentage of teachers supporting less than three dependents as stated in the preceding paragraph. Excepting the group of Marathi Female Teachers these percentages indicate that the average family in case of nearly half the number of teachers, consists of 4 to 6 members.

The percentage of teachers supporting a family consisting of 7 to 10 members is 23. But, it is significant to note that this percentage is very high in the groups of Male Teachers while it is low in the groups of Female Teachers, thus indicating that family responsibility is generally heavy in the case of Male Teachers, but rather light or moderate in the case of Female Teachers. The following percentages are instructive :—

Percentage of teachers with a family of 7 to 10 members :—

Marathi Male Teachers	...	27	p. c.
Gujarati Male Teachers	...	26	p. c.
Urdu Male Teachers	...	28	p. c.
Marathi Female Teachers	...	10·7	p. c.
Gujarati Female Teachers	...	18	p. c.
Urdu Female Teachers	...	14	p. c.

The position of the group of Marathi Female Teachers is the best as only 10·7 per cent. of them have to support from 7 to 10 members.

The average percentage of all the teachers supporting a family of more than 10 members is 4·3. But that percentage is nil in the case of Marathi Female Teachers and Gujarati Female Teachers, but 5 in the case of Urdu Female Teachers. The corresponding percentages for the groups of Marathi, Gujarati and Urdu Male Teachers are 7·7, 2·8, and 6 respectively. The large size of families among Urdu teachers and among Marathi Male Teachers is obvious.

Considering the smallest number of dependents per teacher as a sign of sound economic position, the six groups of teachers in a descending order stand as—Marathi Female Teachers, Gujarati Female Teachers, Urdu Female Teachers, Gujarati Male Teachers, Urdu Male Teachers and Marathi Male Teachers.

SAVINGS

Under this heading we shall first consider the cases of those teachers who have insured their lives. Insurance has become a necessity especially to middle class people in modern times. We have 388 teachers out of 1164, that is 33·3 per cent. of the total number of teachers who have insured their lives. The following table showing the details about insurance is significant :—

Amount of insurance	No. of teachers	Percentage to the total number of teachers
Upto Rs. 500	18	1·6 p. c.
Rs. 1,000	157	13·5 p. c.
Rs. 1,001 to 2,000	93	8·0 p. c.
Above Rs. 2,001	33	2·9 p. c.
Amount of instalment stated	56	4·8 p. c.
Amount not specified	31	2·7 p. c.
	388	33·3

The above details are on the whole satisfactory, as in almost all the cases the amount of insurance is Rs. 1,000 or more. There are 33 teachers in whose case the amount of insurance is more than Rs. 2,001, rising upto Rs. 8,000 in a few cases. In the cases in which the amount of monthly instalment is stated, we are able to infer that in 90 per cent. of such cases the amount is Rs. 1,000 or more. That one-third of the total number of teachers have insured their lives is really encouraging.

Out of 341 teachers included in the three female groups of teachers, only 34, that is about 10 per cent. of them have insured their lives. But in the case of the three groups of male teachers, out of 823 teachers, as many as 354 or 43 per cent. of them have insured their lives. This difference is natural as it is more necessary in the case of males to insure their lives than in the case of females. None of the Urdu Female Teachers has insured her life.

The following table showing the comparative percentages of cases of insurance in each group of teachers is significant :—

Group of Teachers.	Percentage of Teachers who have insured.		
Marathi Males	...	55	p. c.
Marathi Females	...	17	„
Gujerati Males	...	34·6	„
Gujerati Females	...	7	„
Urdu Males	...	9	„
Urdu Females	...	Nil	

The percentage of insurance cases is largest in the Marathi Male group of teachers possibly due to the fact that they are quite middle-class people, their other assets that will be of help to their families in old age or in times of difficulties are limited, and hence to make provision by way of insurance is absolutely necessary for them. A little more than one-third of the Gujarati Male Teachers have insured their lives. The Gujarati Male Teachers are on the whole somewhat better off economically than the Marathi Male Teachers, and hence the percentage of insurance cases is smaller than that of Marathi Male Teachers in their case. But in this connection it is important to note that the average amount of insurance in the case of Marathi Male Teachers is far less than that in the case of Gujarati Male Teachers. In the group of Marathi Male Teachers, we have 46 per cent. of the cases with Rs. 1,000 as the amount of insurance and in 20·6 per cent. of the cases the amount of insurance is Rs. 2,000 or more. But in the Gujarati Male Teachers, we have 30 per cent. of the teachers with Rs. 1,000 as the amount of insurance, and 40 per cent. of them with the amount of insurance being Rs. 2,000 or more. This shows that the Gujarati Male Teachers have on the whole insured for a larger amount than the Marathi Male Teachers. A very small number of Urdu Male Teachers have insured their lives.

That 17 per cent. of the Marathi Female Teachers have insured their lives is encouraging in that group of teachers, especially considering that it is a group of Female Teachers. The amount of insurance is satisfactory being larger than that in the case of Marathi Male Teachers, as we have more than 36 per cent. of the cases in which the amount is Rs. 2,000 or more, and the average amount of insurance comes to about Rs. 1,600.

The group of Gujarati Female Teachers is economically well placed. So it is not perhaps necessary for them to insure their lives with the object of making provision for the future. That is

possibly the reason why only 4 out of 61 teachers have insured their lives.

Turning to other savings, we have data from 29 teachers only, who have stated details about savings in cash. Out of these teachers, 26 are from the group of Marathi Male Teachers and 3 from the group of Gujarati Male Teachers. In a majority of these cases, the savings are in the form of cash varying from Rs. 100 to Rs. 2,000, and in some cases they are in the form of capital invested in purchasing shares. Thus only 2.5 per cent. of the total number of teachers have other savings.

There is another form of saving where the teachers, at their choice, contribute to the Teachers' Contributory Fund, started with the object of encouraging savings among teachers, since August 1930. There are 227 teachers out of 2014, that is 11.3 per cent. of the total number of teachers¹ who are contributing to this Fund. The following are the percentages for different groups of teachers :—

Group of Teachers		Percentage of Teachers contributing to the Contributory Fund
Marathi Male Teachers	...	25.0 p. c.
Marathi Female Teachers	...	12.9 „
Gujarati Male Teachers	...	2.0 „
Gujarati Female Teachers	...	9.8 „
Urdu Male Teachers	...	12.2 „
Urdu Female Teachers	...	Nil

It is obvious that the largest number of Marathi Male Teachers are taking advantage of this Fund. This is possibly due to the fact that Marathi Male Teachers are on the whole on quite an ordinary economic level, and hence they take advantage of such a facility for saving. The very low percentage in the case of Gujarati Male Teachers is due to there being similar private Funds among them for this purpose to which they contribute. In the case of Female Teachers, the percentage is low because it is not so necessary for them to make any saving this way as in the case of Male Teachers. Still the percentage in the case of Marathi Female Teachers is really encouraging, as 12.9 per cent. of them are contributing to this Fund.

1. This percentage is calculated on 2014 teachers who are actually in the Municipal service and not on 1164 teachers from whom we have data. Because information on this point was got from necessary records in the Schools Committee's Office, and hence it was not possible to ascertain how many of those 1164 teachers we had data are contributing to this Fund.

INDEBTEDNESS

Our analysis so far has revealed that out of 1164 primary teachers, 38 per cent. of them have got low salaries being less than Rs. 60 per month. Other sources of income, by way of income from land or income from tuitions are very limited in the case of majority of them. We also learn that the housing accommodation, as far as it can be judged from expenditure on rent, is not satisfactory in the case of 47 per cent. of them. We have also seen that 52.3 per cent. of them are possibly suffering from heavy burden of family responsibility in relation to their salaries. Still it is encouraging that one-third of them have insured their lives in order to make some provision. It is but natural that this position in general will lead to indebtedness.

We have in all 660 teachers out of 1164, that is 56.7 per cent. of the total number of teachers who have incurred debt. But the cases of indebtedness are more frequent in the male groups of teachers than in the female groups. The following table is significant :—

Group of Teachers	Percentage cases of indebtedness
Marathi Male Teachers	69 p. c.
Marathi Female Teachers	28 „
Gujerati Male Teachers	65.4 „
Gujerati Female Teachers	6 „
Urdu Male Teachers	57 „
Urdu Female Teachers	53 „

The group of Gujerati Female Teachers is almost free from indebtedness, while the percentage of indebtedness is largest in the group of Marathi Male Teachers. That 53 per cent. of the Urdu Female teachers are in debt is really a large percentage for that group of Female Teachers. Low salaries due to majority of them being untrained, and large size of families are the main causes for large cases of indebtedness in the group of Urdu Female Teachers.

The following table shows the sources of debt :—

Source of the Debt	Percentage of Cases
Bank	32.4 p. c.
Private Money-lender	32.0 „
Bank and Private Money-lender	22.4 „
Not stated	13.2 „

Nearly in one-third of the cases, debt is incurred from the Bank, while in 22 per cent. more cases, Bank is one of the sources

of debt. Thus it is a good sign to note that in about 55 per cent. of the cases, Bank is either the chief or one of the sources of debt. In about one-third of the cases, debt is incurred purely from private money-lender and in 22.4 per cent. more cases, private money-lender is one of the sources of debt. The table shows that private money-lender is the source of debt in the same number of cases as the Bank is. Thus Private Money-lender and Bank are equally important as source of debt.

When we take a comparative view of the source of debt in different groups of teachers, we find that the Bank¹ serves as the chief source of debt to the largest extent among Urdu Male Teachers, then among the Urdu Female Teachers, and then among the Marathi Teachers. It serves as a source of debt to almost the same extent among Gujarati Male Teachers and Marathi Female Teachers.

It is however significant to note that the Bank serves to the largest extent as one² of the sources for incurring debt among Marathi Male Teachers; and to the least extent among Marathi Female Teachers.

Private money-lender as the only important source of debt, plays a leading part in case of Gujarati Male Teachers. The following table is significant :—

Marathi Male Teachers	...	31 p. c.
Marathi Female Teachers	...	32 „
Gujarati Male Teachers	...	53 „
Gujarati Female Teachers	...	50 „
Urdu Male Teachers	...	8 „
Urdu Female Teachers	...	33 „

In more than half the cases among Gujarati Male Teachers, debt is incurred as shown in the above table from private money-lender which is due to the average large amount of debt in their case.

1. Bank as the source of debt		Percentage of Cases
Marathi Male Teachers	...	28 p. c.
Marathi Female Teachers	...	16 „
Gujarati Male Teachers	...	17 „
Gujarati Female Teachers	...	25 „
Urdu Male Teachers	...	66 „
Urdu Female Teachers	...	46 „
2. Bank as one of the sources for Incurring Debt (Bank and Private Money-lender)		Percentage of Cases
Marathi Male Teachers	...	29 p. c.
Marathi Female Teachers	...	10 „
Gujarati Male Teachers	...	20 „
Urdu Male Teachers	...	12 „
Urdu Female Teachers	...	11 „

It should be noted that private money-lender serves as one of the sources of debt in the same number of cases in which bank serves as one of the sources of debt.

Ordinarily we can say that demands for small loans, within the limit of a few hundreds of rupees, are competently met by the Bank. But in case of large loans, teachers have to go to the private money-lender. .

Debts are generally incurred at a moderate rate of interest varying from 6 per cent. per annum to $12\frac{1}{2}$ per cent. per annum.

We now consider the intensity of indebtedness or the actual amounts of debt. We have already seen that cases of indebtedness are on the whole extensive¹, and more so among the Male groups of teachers, the debts being most extensive among Marathi Male Teachers. The following table shows the actual distribution of debt among 660 teachers :—

Amount of Debt		No. of Teachers	
Upto Rs.	100	...	56
"	200	...	102
"	300	...	96
"	400	...	78
"	500	...	93
"	600	...	44
"	700	...	21
"	800	...	28
"	900	...	14
"	1,000	...	32
"	1,100	...	1
"	1,200	...	13
"	1,300	...	3
"	1,400	...	8
"	1,500	...	18
"	1,600	...	1
"	1,700	...	1
"	1,800	...	1
"	2,000	...	16
"	2,250	...	4
"	2,500	...	3
"	3,000	...	9
Above Rs.	3,001	...	7
Not stated		...	11
		Total.	660

1. In this article while discussing indebtedness of teachers, we have used the words 'extensive' and 'intensive'. By 'extensive' we mean a large percentage of debt cases in any group of teachers ; while by 'intensive' we mean very high amount of debt.

The above details will be more clearly understood in a general way from the following table:—

Analysis of 660 cases of indebtedness :

Details of Debt Amount	No. of Cases	Percentage to the total cases of indebtedness
Upto Rs. 500	425	64·4 p. c.
„ 501 to 1,000	139	21·0 „
„ 1,001 to 1,500	43	6·5 „
„ 1,501 to 2,000	19	2·9 „
„ 2,001 to 3,000	16	2·4 „
Above Rs. 3,001	7	
Not stated	11	
	660	

It is good to note that 64·4 per cent. of the debts are less than Rs. 500 in amount. Out of those, 102 or 15·5. per cent. of the total number of debts are from Rs. 101 to 200. There are 21 per cent. of debts between Rs. 501 to 1,000. Thus in all more than 85 per cent. of the debts are under Rs. 1,000 in amount. There are 7 cases of debt being above Rs. 3,001. One of them is Rs. 10,000 in amount and one is Rs. 8,000. These 7 cases of debt being more than Rs. 3,001 in amount can be considered as abnormal. A debt less than Rs. 500 in amount cannot be considered too big for an average primary teacher. It is a good feature that at least in about 65 per cent. of the total cases of indebtedness, the debt position is not serious or intensive. Hence we can assert that though debt position is extensive among the primary teachers of Bombay, still it is intensive or serious only among 35 per cent. of the teachers who have debt.

The following table shows the burden of indebtedness among different groups of Teachers :—

Group of Teachers	Variation of Debt Amount
Marathi Male Teachers	Less than Rs. 100 to Rs. 3000
„ Female Teachers	do
Gujerati Male Teachers	From Rs. 200 to „ 3,000
„ Female Teachers	From „ 300 to „ 3,000
Urdu Male Teachers	From „ 100 to „ 1,400
„ Female Teachers	From „ 100 to „ 1,200

The debt position is not very serious among the two groups of Urdu Teachers. About Gujerati Female Teachers it should be noted

that out of 61 teachers, only 4 are in debt. These four cases do not indicate any tendency as such. Our general impression about that group of teachers from other details available makes us bold to say that the four cases of debt are rather abnormal or exceptional. In the case of the remaining 5 groups of teachers, debt cases are on the whole representative. However debts which are above than Rs. 3,001 in amount are considered as abnormal.

The actual distribution of debts among the different groups of teachers from the point of the amounts of debts, can be further understood from the following two tables :—

Group of Teachers		Percentage Cases of Debt with an amount less than Rs.500.	
Marathi Male Teachers	...	72	p. c.
„ Female Teachers	...	70	„
Gujerati Male Teachers	...	33	„
Urdu Male Teachers	...	70	„
„ Female Teachers	...	84	„

The table shows that the debt position is not intense among Urdu Female Teachers as 84 per cent. of teachers with debt in that group have debts less than Rs. 500 in amount. The position of the three groups of Marathi Male teachers, Marathi Female Teachers and Urdu Male Teachers is almost similar in point of intensity of debts.

Group of Teachers		Percentage Cases of Debt with amount varying from Rs. 501 to Rs. 1,000.	
Marathi Male Teachers	...	20	p. c.
Marathi Female Teachers	...	22	„
Gujerati Male Teachers	...	19	„
Urdu Male Teachers	...	26	„
Urdu Female Teachers	...	13	„

A word is necessary about the debt position of Gujarati Male Teachers. The total cases of debt included in the above two tables from that group of teachers are only 52 per cent. of the total cases of indebtedness in that group. This means that in the remaining 48 per cent. of the debt cases, the amount of debt is above Rs. 1001. Thus the debt position is comparatively most serious or intense in the group of Gujarati Male Teachers.

It will be now interesting to consider the causes of indebtedness. The following table showing causes of debt is significant :—

Cause for incurring Debt.	No. of cases	Percentage to the total No. of indebtedness.
Family Expenditure ...	191	29 p. c.
Illness ...	125	19 „
Marriage & similar Ceremonies ...	145	22 „
Education ...	33	5 „
To pay off old debt ...	55	8·3 „
Business or Trade ...	11	1·7 „
To purchase land or to repair house ...	54	8·3 „
Court matters ...	5	...
Pilgrimage ...	2	...
Not stated ...	39	6 „
Total ... 660		

The largest number of debts is incurred in order to meet family expenditure. 29 per cent. or a little less than one-third of the cases of debt are thus either due to inadequate salaries or a heavy burden of family responsibility. And we have noted that 38 per cent. of the teachers have got inadequate salaries, while family responsibility is heavy among 52·3 per cent. of them.

About one-fifth or 19 per cent. of the debts are incurred due to illness which is due to life in Bombay conditions, and especially due to the fact that in case of about 47 per cent. of the teachers their housing-condition is bad from the point of view of sanitation or adequate space. That is why illness is prevalent to such a high extent.

Thus 48 per cent. of the debt cases or nearly half of them are due to causes connected with the teachers' salaries and life for lower middle-class people under Bombay condition.

A little more than one-fifth or 22 per cent. of the total number of debt cases are due to marriage and other expensive social customs. These debts are due to the social life and customs of the people, and they are in the habit of incurring debt on these items irrespective of considerations of their salaries as such.

In the remaining cases, debts are incurred for education, or in order to pay off hereditary debts, or due to loss in business etc. Only one item we need note. There are 54 cases or 8·3 per cent. of the total number of cases where debt is incurred in order to

purchase land or to build or repair a house. The nature of these debts is not bad, as directly or indirectly they are meant for some constructive aspect. Similarly debt incurred for education of some dependent is not bad.

Thus nearly one-half of the debts are due to life under Bombay conditions or problems connected with teachers' salaries, whereas in about 13 per cent. of the cases where debts are incurred for education or land or house, their nature is not bad and in one-fifth of the cases they are due to extravagant or expensive social customs.

Some comparative considerations about different groups of teachers are interesting and instructive on this point.

Comparative Position of Debts due to
Family Expenditure :—

		Percentage of cases.
Marathi Male Teachers	...	29 p. c.
Marathi Female Teachers	...	28 „
Gujerati Male Teachers	...	22 „
Urdu Male Teachers	...	22 „
Urdu Female Teachers	...	36 „

The high percentage in the case of Urdu Female Teachers is due to their low salaries, majority of them being untrained. In the remaining groups, from 22 to 29 per cent. of the teachers have incurred debt in order to meet current family expenditure. This shows that to meet current family expenditure is a problem to about one-fourth of the Primary Teachers. It is indicative of their poor economic state.

Comparative Position of Debts due to
Marriage and other Social Customs :—

		Percentage of Debt cases.
Marathi Male Teachers	...	16 p. c.
Marathi Female Teachers	...	13 „
Gujerati Male Teachers	...	22 „
Urdu Male Teachers	...	44 „
Urdu Female Teachers	...	25 „

This shows how social customs are predominant especially among Urdu Teachers. Social customs also count to a certain extent among Gujarati Male Teachers. The smallest number of cases of indebtedness due to social customs is to be found in the case of Marathi Teachers. Though social customs play an important

part among Marathi Teachers, still they are not expensive in these matters as the Urdu or Gujarati Teachers.

Comparative Position of Debts due to Illness :—

	Percentage of cases.	
Marathi Male Teachers	...	20 p. c.
Marathi Female Teachers	...	28 „
Gujarati Male Teachers	...	13 „
Urdu Male Teachers	...	18 „
Urdu Female Teachers	...	17 „

Illness is very predominant in the group of Marathi Female Teachers. The percentage of cases of indebtedness is least among Gujarati Male Teachers on account of illness. This is possibly due to the fact that an average Gujarati or Urdu Teacher is stronger in health than an average Marathi Teacher. That may be the reason for the varying percentages in the above table for different groups of teachers.

Comparative Position of Debts incurred in order
to pay off Old Debts :—

	Percentage of cases.	
Marathi Male Teachers	...	9 p. c.
Marathi Female Teachers	...	Nil
Gujarati Male Teachers	...	9 p. c.
Urdu Male Teachers	...	7 „
Urdu Female Teachers	...	6 „

The above comparative tables reveal that to meet current expenditure is a problem, equally pressing, in the case of all the groups of teachers excepting the group of Gujarati Female Teachers. Expensive social customs are very predominant among Urdu Teachers and to a certain extent among Gujarati teachers. Illness is very common among Marathi Teachers, but especially among the Marathi Female Teachers.

CONCLUSION

The Municipal Primary Teachers of Bombay are divided into three principal groups, Marathi, Urdu and Gujarati Teachers in a descending order according to their number. Each group is divided into two sub-groups of Males and of Females. A majority of them are drawn from a few of the Marathi and Gujarati districts and the city of Bombay proper, while a few of them, who are on the Urdu side, come from every part of India. They are in the main Hindus and Mahomedans, but a few of them are Parsees, Jews and Indian Christians. They are on the whole qualified for their

profession as the majority of them are trained and one-third of them have knowledge of English. Majority of them are quite young in the full vigour of their life, and more than half of them have experience of teaching for more than 10 years. Their income from salaries varies from Rs. 30 to Rs. 150 per month, but in case of 38 per cent. of them, it is low being less than Rs. 60 per month. Very few of them have any means of adding to their income by means of other sources. Only about 16 per cent. of them have got land to fall back upon in times of difficulties. The average number of dependents in relation to their incomes appears large in case of about 52·3 per cent. of them. Hence about one-third of the teachers who have incurred debt, have done so in order to meet current family expenditure. About 47 per cent. of the total number of teachers do not live in well-ventilated rooms, and hence illness is common among them. About one-fifth of the total cases of indebtedness are due to it. About 56 per cent. of the total number of teachers have incurred debt varying from Rs. 100 to Rs. 500 in a majority of cases, as their means of income fall short to enable them to meet their expenditure under Bombay conditions. Expensive social customs are also predominant among some of them, as one-fifth of the cases of indebtedness are due to that. In spite of the adverse circumstances under which they have to work, it is a good sign to note that about one-third of them have made provision for the future by insuring their lives. It is also a good sign that 11 per cent. of them are contributing to the Contributory Fund started since 1930. Considered from tests like income, rent, number of dependents, indebtedness etc., it seems that the group of Gujarati Female Teachers stands best. It is followed by the group of Marathi Female Teachers. While the remaining four groups of teachers seem to stand almost on the same level, with a few differences here and there in some of the points.

B. M. KALE, M.A., B.T.

“DR. HAYEK¹ AND THE THEORY OF CRISES”

“A series of important inter-connexions have been established and some principles of the greatest significance expounded ; but no one has yet undertaken the decisive step which creates a complete theory by using one of these principles to incorporate all the known phenomena into existing system in a satisfactory way.”

—*Dr. Hayek*²

“From the beginning it is clear that a methodical criticism could not leave a brick standing in the logical structure built up by Dr. Hayek.”

—*P. Sraffa*³

I

The phenomena grouped under the title ‘The trade cycle’, constitute a challenge to economic theory as well as to economic welfare. Dr. Hayek, a leading representative of the School of Vienna, “has made important contributions to our understanding of some aspects of the trade cycle”⁴. In the following paragraphs an attempt is made to state and appraise these “contributions”.

This attempt, however, is subject to certain limitations. (a) Economists share with lizards on the hedge a measure of notoriety with reference to stability of opinion. Dr. Hayek is probably no exception and there is thus the difficulty of putting an enclosure on living thought. (b) One chief advantage of Dr. Hayek’s theories being that they are violently provocative of thought, controversies have been a normal feature of their discussion. There was a sword-play between Mr. Keynes and Dr. Hayek⁵. And

1. “The Monetary Theory and the Trade Cycle”, and “Prices and Production”, published in English in 1933 and 1931 respectively, are the two special works of Dr. Hayek on the subject of the trade cycle. The references in this essay are to their first editions. Separate studies of Dr. Hayek’s theory may be found in A. L. Macfie’s “Theories of the Trade Cycle”, Chapter IV to VI ; T. E. Ellis’ “Recent German Monetary Theories” ; and M. A. Abram’s “Money”.
2. The Monetary Theory and etc. P. 40.
3. The Economic Journal, March 1932, P. 45.
4. The Economic Journal, December 1933, P. 597.
5. For a useful account see G. L. S. Shackle’s article in Vol. I, No. 1. The Review of Economic Studies.

recently¹, Professor Frank H. Knight had made a gallant attack on some of the important elements of the theory. Although an effort has been made here to make use of the more important results arising out of these duels, it will be impossible to touch, much less to exhaust all the various aspects of economic theory on which this inquiry abuts. (c) Dr. Hayek is vague as to the demand and supply functions of credit. Do they depend on prices, or price derivatives etc., or on any combination of these? Do certain lags exist? Such questions are either not raised at all or their answers are not clear enough. (d) No statistical verification of the theory has been made². There are, (as will be shown later), theoretical objections to and practical difficulties in getting at such a result. (e) No direct comparison is instituted of the views of say, Keynes, Hawtrey and others with those of Dr. Hayek, although it might have proved illuminating and instructive since a fair measure of similarity exists between them despite marked differences on important details. (f) I am not insensible to the imperfections introduced in these notes by want of knowledge, especially regarding the relevant continental literature on the subject.

Dr. Hayek's views on the theory of crises are for the greater part expressed in two books: "The Monetary Theory of the Trade Cycle", and "Prices and Production". He wishes the two books to be considered as being complementary to one another. "While I have here emphasized the *monetary* causes which *start* the cyclical fluctuations, I have, in that later publication, concentrated on the *successive changes in the real structure of production* which constitute those fluctuations."³ Besides these two works, Dr. Hayek has contributed fat articles on topics connected with the subject to the leading economic journals.

As a sort of preliminary, Dr. Hayek insists on three points in order to prepare the soil for the reception of his theory. It is possible to agree with him on these points without committing oneself anyway. They are: (A) the proper relation of Fact to Theory; (B) the failure of the static equilibrium analysis to explain the phenomena of the trade cycle; and (C), the inadequacy of non-monetary theories of the trade cycle.

(A) The relation between empirical observation and theoretical explanation is such as to render the latter the superior partner in economic analysis. "It is not by enriching or by checking theoretical

1. More particularly in the *Economic Journal*, March, 1935.

2. See however, Lionel Robbins' classic, "The Great Depressions".

3. "The Monetary Theory and" etc. P. 17.

analysis that economic statistics gain their real importance"¹. Facts are blind without a theory; their collection, consciously made or otherwise, is made under the inspiration of some theory. Two important results follow in the present connexion. (a) "Even as a means of verification, the statistical examination of the cycles has only a limited value for trade cycle theory"². and (b) "the oft-repeated assertion that statistical examination of the Trade Cycle should be undertaken without any theoretical prejudice, is therefore always based on self-deception"³. Although it is true that without a pre-existing theory we shall be led inevitably to the nirvāna of purposeless observation, such a deductive approach has certain pitfalls about which one must proceed very gingerly. "The danger inherent in all deductive systems, that actual conditions may be ignored or never realised, is always present in this approach"⁴."

(B) Equally valuable is the pointed assertion that the *static* equilibrium analysis fails to account for the phenomena of the boom-and-depression-and-revival sequence. Of course this does not mean that this analysis is faulty. Only one *extension*⁵ is demanded in order to cover the case of the crisis. The central idea of the equilibrium concept (necessary in *all* the branches of equilibrium analysis) can be expressed as follows: the economic process is, as a whole, theoretically viewed as a "flow" partly of "material" through various "forms"; partly of activity ("services") not connected with a transformation of materials: in any such process, the flow necessarily "equilibrates" the potential difference which causes it and tends to come to a stop. What is essential to know is that everything that happens in organized economic life (i.e. a price economy) tends to equilibrate or destroy some *price-difference*. Hence the concept of equilibrium. Now, in the pure theory of static equilibrium, incomes fluctuate with the value of marginal net products and hence no *general* disequilibrium can arise. The real difficulty with an effort to account for the trade cycle on the basis of this analysis is: "Why do the forces tending to restore equilibrium become

1. "The Monetary Theory and", etc., P. 35.

2. "The Monetary Theory and", etc., P. 32.

3. Ibid. P. 38.

4. Macfie, P. 50.

5. cf. Mitchell, "Business Cycles", 1927: "To determine how the fact of cyclical oscillations in economic activity can be reconciled with the general theory of equilibrium, or how that such theory can be reconciled with facts is no part of his job.

temporarily ineffective and why do they only come into action again when it is too late¹ ?”

This enables one to appreciate the special task before a trade cycle theory and hence its need. The economic changes that can be contemplated under the assumptions of static equilibrium conditions are all by nature of *adaptations—directly proceeding* from the old to the new equilibrium. The *raison d'être* of the trade cycle theory is just this : “The simple fact that economic development does not go on quite uniformly, but that periods of relatively rapid change alternate with periods of relative stagnation, does not in itself constitute a problem.....The real problem presented to economic theory is : Why does not this adjustment come *smoothly and continuously*, just as a new equilibrium is formed after every change in the data ? Why is there this temporary possibility of developments *leading away from equilibrium* and finally, without any changes in data, necessitating a change in the economic trend² ?” This is a really admirable way of defining the *scope and aim* of the theory of crises. Dr. Hayek has put the matter even more concretely : “We have to start where general economic theory stops ; i.e. at a condition of equilibrium when no unused resources exist. The existence of such unused resources is itself a fact which needs explanation. It is not explained by static analysis³.”

(C) Something like 50 pages of the “Monetary Theory and the Trade Cycle” are devoted to an examination of the “non-monetary theories”. Dr. Hayek sometimes flogs horses which are (or should be) dead or on which he himself occasionally takes rides. Most of the “non-monetary theories” dash on this rock : “they overlook the fact that in the exchange economy, production is governed by prices, independently of any knowledge of the whole process on the part of individual producers, so that it is only when the pricing process is itself disturbed that a misdirection of production can occur⁴.”

As Macfie observes, it is the *credit element* of the money system that is regarded as the villain of the piece⁵. It is not too clear just what ‘monetary system’ means. In fact, Dr. Hayek himself calls his theory the “Additional Credit Theory of the

1. “The Monetary Theory and,” etc. P. 65.

2. Ibid, P. 55.

3. “Prices and Production”, P. 31.

4. “The Monetary Theory and”, etc. pp. 84-85.

5. Macfie, P. 46—footnote.

Trade Cycle¹." The explanation offered is called 'monetary' for two reasons: (i) "money being a commodity which, unlike all others, is incapable of finally satisfying demand, its introduction does away with the rigid interdependence and self-sufficiency of the 'closed' system of equilibrium, and makes possible movements which would be excluded from the latter"². (ii) "The possibility of alterations in the *quantity of money occurring automatically*³", and the consequent disturbances in *prices* as constituting the major cause of the trade cycle.

II

A succinct statement of the theoretical position may be useful to be explained in detail immediately :—

"The real problem is the growth of excessive fluctuations in the capital goods industries out of the inevitable and irregular fluctuations of the rest of the economic system, and the disproportional development arising from these, of the two main branches of production⁴". The explanation is as follows: "There is an over-expansion of credit, from which emerges the phenomenon of 'forced saving'. As a result, the 'production process' gets 'lengthened' far beyond what can be really sustained by it. This 'lengthening' constitutes the boom and its 'contraction', the crisis."

The *assumptions* of the theory, which is, to use the well-known term of classification, 'monetary', 'endogenous'⁵ and 'institutional', in substance amount to the proposition that the trade cycle is possible only in an economy where (i) there exists money; (ii) the profit motive is given a full play; (iii) the production is carried on with the help of capital goods; and (iv) where obtains a system of free competition and consequently of flexible costs. The rest of the assumptions underlying Dr. Hayek's theoretical analysis are not very precisely stated. This lands him into difficulty⁶. Like Ricardo he leaves it to his readers to undertake to inquire for

1. "The Monetary Theory, and", etc. P. 177.

2. Ibid, P. 44.

3. Ibid of Pp. 93-4.

4. Ibid P. 60.

5. Ibid P. 59 : No theory of trade cycle can dispense with the *assumption* of initial changes. This tampers with endo-geny.

6. cf. P. Sraffa in the *Economic Journal*, P. 45 : "The essential condition is that Dr. Hayek must both assume that the "consumers" are the same individuals as the "entrepreneurs", and that they are distinct", etc.

themselves into the presence or absence of these assumptions at a particular spot in his argument. He is an abstract thinker. He flatters his readers by assuming them to be too intelligent.

It is important to note what types of economic system are or have been certified by Dr. Hayek to be immune from the trade cycle. First, no barter economy can contain any germs of the crises. For it is a moneyless economy. But, it might be observed, it is possible to argue theoretically that a barter economy is not necessarily free from fluctuations. Second, the socialistic economy. Here the profit motive is inoperative. Third, Dr. Hayek would have it that an economy where capital goods are not used cannot present the spectacle of the trade cycle. This is arrived at by dropping the round-about-production economy assumption. Yet, as Professor Knight points out¹ there is no theoretical reason why there should not be fully developed and completely typical trade cycles in a society in which no capital goods whatever were used. "Such a situation may be visualised by considering what might happen if all economic production had the form of personal services. The phenomena of training periods and resistance to retraining, in relation to changes in demand, and to money, credit and prices and their changes and resistance to change, would be present and adequate to give rise to all the characteristic manifestations now met with." Four, there is one more case stated by Dr. Hayek in which there is elimination of the trade cycle—it is that type of economy where capital development necessary for the greater production of consumers' goods is supported through the "voluntary savings" by the consumers. More about this later. Five, since one of Dr. Hayek's assumptions is of completely flexible cost and price system, an economy that is characterized by a *rigid* economic structure (different again from a barter economy) should not be expected to bear the pangs of the trade cycle. Without anticipating the argument developed afterwards in the later part of this essay, it may be pointed out here that Dr. Hayek has in fact advanced his theory in a system of flexible costs and prices. Such an attempt is vitiated for the very obvious reason that the assumption of flexibility of the prices does away, lock, stock and barrel, with the problem of "forced saving". Through the retention of this assumption in his analysis Dr. Hayek has abolished the very basis of his trade cycle theory viz., the role of money in connexion with the rigidities of the price economy. Finally, it might be mentioned that the idea, "an economy with a 'neutral

2. P. 95, in the *Economic Journal* for March, 1935.

money"¹—whatever that means—is free from trade cycle" is not—only suggested but held out as "our maxim of policy".²

III

The *fourth* case mentioned above is employed by Dr. Hayek as an important porch to his analysis of industrial fluctuation. It may be conceded that the equilibrium position in the economy resulting after the production of producers' goods has been financed out of 'voluntary savings'³, made by the 'consumers', is stable.

The reasons advanced by Dr. Hayek do not, however, *strengthen* this conclusion. He states that the 'savings' are 'voluntary'—not imposed. That might, so it seems to be suggested, be one reason why the order thus voluntarily asked for is respected. The second and the more important ground for the stability of the equilibrium is stated as: "After the change had been completed (i.e. increased employment of capital goods) these persons would get a greater proportion of the increased total real income..... There would accordingly exist no inherent cause for a return to the old proportions⁴." But "proportions of the total income" have little relevance to "decisions of individuals". To reply to such an idea in his own words: "for none of these magnitudes *as such* ever exerts an influence on the decisions of individuals⁵." Dr. Hayek has exaggerated (unnecessarily) the wisdom and foresight of his 'consumers'. It seems to me (see Sraffa's foot-note quoted above) that Dr. Hayek's investor is usually drawn from the "educated middle-class!" Altogether, this is a fine illustration of what the psychologists call the process of rationalisation. And this is not a solitary instance.

If Dr. Hayek's arguments are not here convincing, his right-angled triangles, which are supposed to illustrate and simplify the matter are equally confusing. They are drawn in order to show a picture of the 'synchronised process of production'. There are two ways⁶ in which this process of production has been approached. (a) Take a *cross-section* through social production at a moment of

1. See 'Neutral Money and the Trade Cycle,' by Harold Barger in "Economica" for November 1935.
2. "Prices and Production", P. 106.
3. "Saving" according to Dr. Hayek would be an increased in the proportion of the total flow of money directed towards the purchase of 'producers' goods.
4. "Prices and Production," P. 52.
5. Ibid, P. 4.
6. cf. Wicksell: Lectures on Political Economy, P. 236.

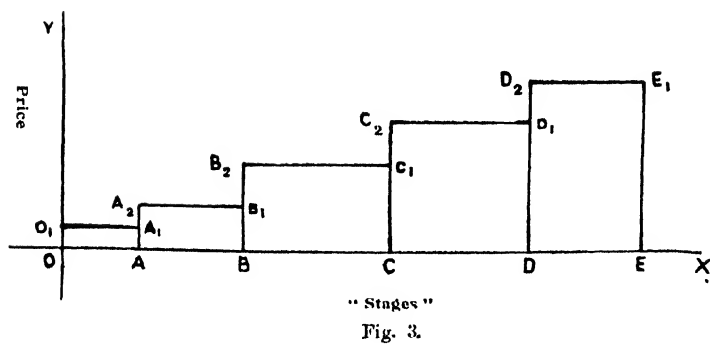
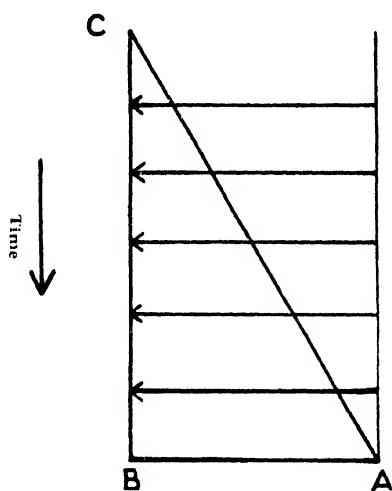
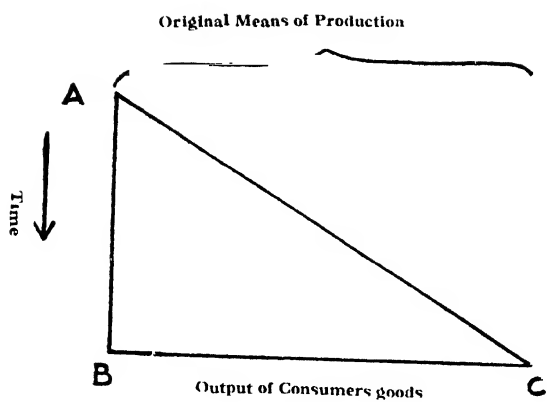
time and thus consider only the co-operation of the factors of production existing at the moment. Here then, the demand for finished products constitutes an indirect demand for raw materials and the factors of production, by means of which the 'finished products' are produced. (b) Refer everything back to the "original means of production"¹ in conjunction with "waiting" (or preferably time). This is a longitudinal-section.

It is the latter which is used by Dr. Hayek when he draws his triangles. It might appear that the first method of representing the process of production in economic society has been rightly left out. For does it not show that process at a given second of time? Of what use could it be when the object is to get at an internal development in the economic structure *taking time*? Of course it is true that we have to analyse continuous production directed towards future. Dr. Hayek would supply two more reasons for his choice: Capital—the result of "waiting" is a factor of production; and secondly, the very dominant role that the rate of interest plays in modern economy and especially in the money economy. In the right-angled triangle diagram², the base represents costs embodied in the output of "final products"; and the vertical distances from the base to points on the hypotenuse represent the periods for which successive units of "original resources" are invested. Changes in area and base therefore illustrate changes in the quantity of intermediate products which must exist simultaneously to maintain a given output of 'final products', with "processes of varying length". That the productive process has a "length" is an integral part—and the sluice-gate of much mischief—of Dr. Hayek's theory.

Figure I represents "the processes of production going on simultaneously in a stationery society²." The triangle is tilted in figure II to clarify the idea. An improvement on both will be figure III. It makes Dr. Hayek's ideas clearer and the exposition followed here simpler³. To retain the use of the ideas and terminology of the Austrian School, the figures represent the gestation of a good in the productive system.

"At first glance it might seem improbable that the prices of the successive stages of one and the same line of production should

1. Prices and Production. P. 33: "When I mean land and labour, I shall speak of original means of production."
2. "Prices and Production," P. 37.
3. I may add that this figure was suggested by the "fan" idea on P. 73. of "Prices and Production," and that it is the *comparative length* that is to count in Hayek's analysis, i.e. $A_1 A_2$: $B_1 B_2$ and etc.



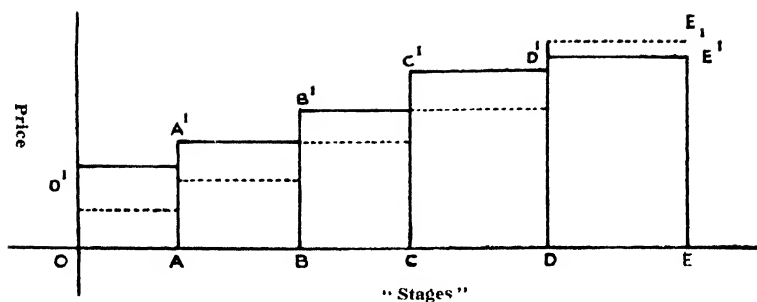
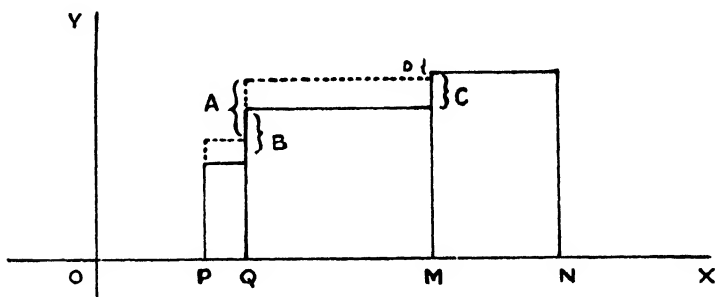
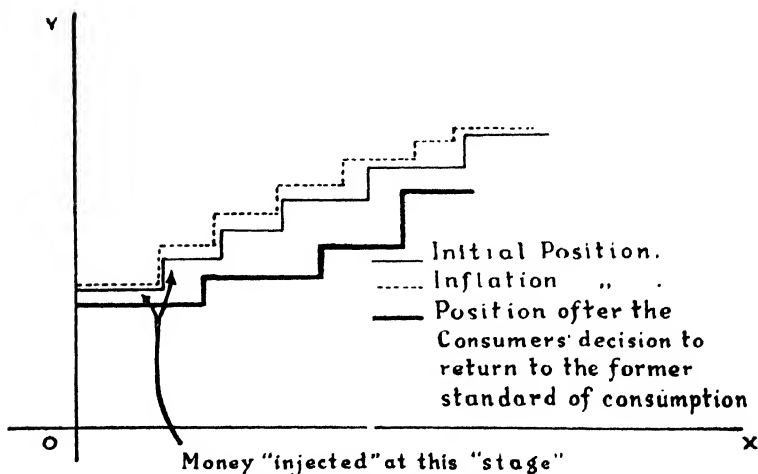


FIG. 4.



B and C were the margins existing before the loan. Hence the shift of productive activity from MN to PQ.

Fig. 5.



Note: 1. See the number of "stages" at different times.
 2. Only the margins are significant, i. e. the perpendicular lines in the diagram,

Fig. 6.

ever fluctuate relatively to one another because they are generally dependent on the price of the final product¹". In other words, these price bars AA_2 , BB_2 , CC_2 , etc. in the third diagram are dependent on EE_1 . "But there is the possibility of *shifts* between the demand for consumers' goods and the demand for producers' goods." As a consequence "the continuance of the existing degree of capitalistic organization depends, accordingly, on the prices paid and obtained for the product of each stage of production and these prices are, therefore, a very real and important factor in determining the direction of production²."

How do these shifts occur? They occur (note the chronology) as a result of some change—*external to economic society*—in demand for consumers' goods³. As a consequence, there is a corresponding change in the demand for producers' goods. The precise movements of price bars—as Dr. Hayek would have them—may be noted. See Figure IV where it is assumed (following Dr. Hayek) a rise in demand for the consumers' goods, facilitated in its satisfaction by their shrewd and generous 'voluntary saving'. It seems to be an unmentioned but very active assumption of Dr. Hayek that producers' goods work on the economic good in the "earlier stage" of production. As the demand for such goods rises as a consequence of the consumers' decision to have more goods for consumption, there is a *fall*, comparatively as well as absolutely (and hence larger in consequence), in the price bar EE_1 , (Fig. IV) say to EE^1 . And it is argued that there is similarly a *rise* in the price bars at AA_2 , BB_2 , and so on, to say AA^1 and BB^1 etc. Hence, it is argued, the "price margin" between the two price bars AA^1 and EE^1 has *diminished*; and that accommodation or equilibrium in the changed circumstances has to be provided by increasing the number of "stages" of production through the process of getting more "round-about".

Let two things be noted here. (i) Dr. Hayek could have usefully neglected in our opinion, all reference to "period of production" and the allied concepts and yet retained the attractions of his theory. (ii) But, on the contrary, admirers⁴ of his theory have maintained that: "It is, however, in describing the mechanism of such disturbances, the successive changes in the real structure of production which are initiated by an expansion of

1. "Prices and Production", P. 68.

2. Ibid, P. 44.

3. See however, the footnote on P. 69 of the 'Monetary Theory and the Trade Cycle'.

4. The Review of Economic Studies, Vol. I, No. 1, P. 33.

the circulating medium, that Dr. Hayek has shown a new horizon^{1 & 2}”.

There are three objections upsetting the latter view :—

(a) There can be no such *linear* view of the production process.³ There seems to be a one way traffic from O to E. This has an important result. The *price-ladder* OO^1 , A_1A_2 , B_1B_2 , C_1C_2 , D_1D_2 whose flexibility plays roles of such vast importance *cannot* be shown to exist in reality even with reference to one single commodity. There might be no ladder at all ; just a loop or even a most intricate web of wavy lines.

(b) Secondly, this diagram is called upon to do the work of two more (or even three) although it refers just to one commodity and with the serious defect mentioned above. It is clear that the price bars fluctuate in their height ; and that their fluctuations are due to changing demands for the consumers' and producers's goods *whose prices, it is, which fluctuate* with the fluctuation in these price bars as a *consequence*. It would have been useful to represent these two things separately. (See Fig. V.) The fifth figure shows that while the third and fourth figures stand for the price-formation in the (straight, linear) career of a single commodity, the forces, (i.e. the shifts described) cause the prices of *various goods*⁴ to fluctuate and just a part of their fluctuation is passed on to raise or to lower the steps in the ladder, assuming its existence.

(c) It is at least a large possibility that the “length” of the round-about way—if at all such a thing is possible to find out—varies only very slowly and continuously. Bohm used the concept of the round-about method of production only for *long period* static equilibrium problems. The notion is less useful for rapidly changing situations. Sticking to Dr. Hayek's terminology, “Round-about-production” = “Period of production”, = the number of “stages” passed, is true (if at all any such thing can be true) in that simple case which consists of production without

1. See Frank H. Knight's article, “Capital, Time and the Interest Rate”, in *Economica* for August 1934. He points out clearly that although one can ‘date’ any particular transformation of material into one state or another, the dates might interest an historian of a sort—“they certainly do not bound a period of production” P. 275.
2. “The term production I shall always use in its *widest possible* sense, i.e. all processes necessary to bring goods into the hand of the consumer.”—*Prices and Production*, P. 33.
3. cf. *The Review of Economic Studies*, P. 233, II, 3.
4. In the figure V the finished product (the last two stages) and one capital good used in making it are shown in their price fluctuations.

any long lasting means of production. *Durable* goods do not lead a *momentary* existence.

Further, as will be presently shown, connecting this "period" concept with the "quantity of capital" in the society and making its "length" dependent upon that "quantity" only serves needlessly to damage the sound parts of this theory and to make its exposition cumbersome and difficult and confused.

IV

One is now in a position to follow Dr. Hayek examining the features of that ill-fated economy which as apart from and in contrast with the other types of economy mentioned above, is so peculiarly liable to trade cycle attacks. Such an economy is characterised by the capacity to create independently any amount of credit. "The technical proof of Dr. Hayek's monetary theory depends on showing that elasticity of credit is a factor imminent in any system of free enterprise where a central bank is only the central body in a system of partly independent joint-stock satellites¹". We have to show how, with our independent joint-stock banks it is possible—no, inevitable, that credit will be increased beyond the amount necessary to secure that the cost of investment will be recovered. In other words, that during a growth of trade activity the actual rate of interest will inevitably be kept below the equilibrium rate². There are three facts on which all this rests: firstly, the fact that we have several autonomous competing banks with the power to increase their loans to producers; secondly, the fact that the aim of these banks is to make profit for their shareholders; thirdly, the fact that loans advanced originally by one bank create deposits in others, which in turn provide a solid basis for expansion by these other banks.

The smashing emphasis given by the theory to the rate of interest, its movements and the part they play in the economy should be carefully noticed³. In passing one can say that in economic doctrines too, every dog has his own day. Gold, land, machinery, protectionism, equilibrium and now the rate of interest—these have formed in the last 175 years economics—has been discussed separately,

1. Macfie. P. 57. Hence I characterized the theory as institutional. The theoretical sword that was rattled while talking of equilibrium analysis, has been quietly sheathed and the account of the trade cycle is stated with one particular type of banking system.
2. See note on Rate of Interest at the end.
3. Vide, the quotation given later. Its terse summary of Dr. Hayek's position and the fact that it is comparatively free from references to "periods of production" are the two grounds why it is quoted in full.

the chief centres of thought. The rate of interest is the rate of paying the price for the *use* of capital. Each category of capital has its own particular problems and its own sets of prices and rates of interest.

Dr. Hayek's idea is to isolate the rate of interest; to study the effects of manipulating it on the credit supply; and to carefully watch the consequences of variations in the credit structure on the economy. Very briefly, his argument (or his idea of the sequence of events) is as follows¹: (1) The actual rate of interest is made lower than the "natural rate" of interest. (2) This acts as an incentive to entrepreneurs to borrow. (3) The borrowed loans are used for creating capital goods (with the hope of producing with them in future more consumption goods for which there seems to be now a persistent demand). (4) The loans advanced by the banks to entrepreneurs being not equal to the deposits with them are inflationary in nature and the prices rise. (5) As a result of the prices rising, the consumers find that their command over the consumption goods is being unnecessarily and involuntarily retrenched and (6) they decide to tolerate matters no further, and (7) a dash is made to buy things and restore the expenditures to their former proportion. (8) Hence the direct production of the materials they require is more profitable than to wait to get profits in the future through sale of goods produced with the machinery acquired through the finance furnished by the banks by lowering their rate of interest. (9) Hence, the resources of production are not employed in producing machinery but shifted to produce a greater number of consumers' goods. (10) The constructive industries are therefore kept idle—there is unemployment of both capital and labour², because the new undertakings made with the hope of producing capital goods are now given up as not being profitable.

This is the sequence of significant events generated by the decision of the bankers to allow a comparative disparity between the "equilibrium" and market rates of interest—making the latter lower than the former. Dr. Hayek points out that such a disparity may exist on account of the movement either of the bank rate or of the equilibrium rate itself³. (Hence the fallibility of the bankers.)

1. See Figure VI.

2. D. H. Robertson in his 'Banking Policy and the Price Level' points out: "The most external manifestations of the trade cycle...are a quasi-rhythmical movement in the level of prices, in the level of money profits and in the level of employment." P. 6. This part of Dr. Hayek's theory explains these "external manifestations".

3. cf. "Prices and Production," pp. 21-22.

"The Monetary Theory" etc. pp. 111-120.

Examination of Dr. Hayek's explanation therefore, must take into account not only the various items detailed above but also their sequence. It may be noted here, once and for all, that the influence (though theoretically it is justifiable) of the rate of interest on the organization of production is not in isolation. To isolate it for purposes of study is one thing and to deify it with omnipotence is another. A passage may now be quoted summarising some of Dr. Hayek's ideas very clearly : "Every given structure of production, i.e. every given allocation of goods as between different branches and stages of production, requires a certain definite relationship between the prices of the finished products and those of the means of production." (Dr. Hayek has taken into account only one 'means of production', capital. The rest are either not taken into account at all or are 'neutral' through being 'constant'.) "In a state of equilibrium the difference necessarily existing between these two sets of prices must correspond to the rate of interest"—and one is tempted to say, to any other variable remuneration of the factors of production. "And at this rate, just as much must be saved from current consumption and made available for investment as is necessary for the maintenance of the structure of production. The latter condition necessarily follows from the fulfilment of the former, since the prices paid for the means of production, plus interest, can only correspond to the prices of the resulting products, when, at the given prices and rate of interest, the supply of producers' goods is exactly adequate to maintain production on the existing scale. The price margins between means of production and products, therefore, can only remain constant and in correspondence with the rate of interest so long as the proportion of current income, which at the given rate of interest is not consumed but re-invested in production, remains exactly equal to the necessary capital requirement to carry on production. Every change in this proportion must begin by impairing the correspondence of price margins and the interest rate ; for it influences both in opposite directions, and so leads to further shifts in the whole structure of production, representing an adjustment to altered price relationships¹." These shifts in the structure will have *different* consequences according to whether (a) they were results of changes in the decisions of individuals as to spending and saving i.e., lowering of the entire supply schedule of saving ; or (b) the shift was brought about artificially, "without any corresponding changes in individual saving activity."

1. The Monetary Policy and the Trade Cycle, P. 212.

It is this latter case that is now to be under observation. The first question to be asked is this : Is there any great distinction between the effects of capital advancement when (i) it is advanced voluntarily and by the consumers, and when (ii) it is automatically created by the banking system. Dr. Hayek says : " there is, and that it consists in the different stabilities of the positions reached ; in (i) the position is ' stable ' and in (ii) it is unstable—the return to stability being *via* the occurrence of the depression in the trade cycle". Dr. Hayek thus presents a diametrical difference between the two cases.

It is submitted here that if the first case contains the position of stable equilibrium, *equally* stable would be that position if brought about by inflation ; and Dr. Hayek fails to prove the contrary. In fact, he has needlessly exaggerated the contrast between the two cases. The new " proportions " reached can be assumed to persist only so long as is maintained the supply of credit to get capital. In the second case " a progressively increasing rate of credit creation¹ " makes a *termination*—it is *this* that matters, and not " voluntary " or involuntary aspects of " saving "—sooner and surer than that in the first case. That is the difference. It is better not to beg the question and define it in terms of equilibrium positions.

Question two is : *Can the equipment of a community be enlarged by inflationary capital loans ?* It is true that a lower rate of interest accelerates the production of capital goods. But, as Mr. Hawtrey observes² in another connexion, the assumption that producers' credits must in the main be spent on fixed capital, is gratuitous and fallacious. A portion only is spent on it. Dr. Hayek unnecessarily magnifies such expenditure³. Again the addition to capital stock made this way would represent but a small fraction of the total capital equipment of the Society and

1. "The Monetary Theory and ", etc., P. 215.

2. in "Economica", November 1935, P. 463.

3. There are other exaggerations as well. Mr. D. H. Robertson writes in a footnote on page 653 of the *Economic Journal* for Dec. 1934 : "The Austrian School" seems to tend to over-stress the importance of such intermissions of half-finished constructional enterprises as compared with the failure to undertake new ones ; also to exaggerate the embarrassment which the rising of *current* interest-rates will cause to those who have taken in hand the extensions financed out of windfall profits, or cut off long loans raised at the lower rates : also to exaggerate the speed at which saving can be disentangled from fixed instruments, and therefore the danger that the boom-expansion of fixed capital will be lost the railways built in the forties are still with us.

hence Dr. Hayek's ground is to that extent still more narrowed. Question three is : *Why should not the inflationary loans go on for ever ?* The banks cannot permit their reserve ratios to fall below a certain minimum. Assume such a minimum is not there. Yet it would be possible to say that a termination of credit supply is inevitable. The greater the previous amount of loan, due to a rise of prices, the greater will be necessary as the next loan to have a command over the same capital unit. Because capital creation goes hand in hand with currency depreciation. Further, as soon as the new loan leaves the sphere of investment and enters that of consumption by way of incomes its *saving effect* is gone and tends to be offset by a consumption effect.

It is the contention of Dr. Hayek that the termination of the inflationary loan marks the occurrence of the crisis. In other words, not only is the capital produced through these loans ; but that because it is not produced more shows the imminence of the crisis. It is clear that behind this is the idea of the lack of capital i.e. insufficiency of free capital for the completion of new plants under construction. It is linked with the concept of forced saving. Forced saving is due to the fact that the present economy is marked by price rigidity and stickiness ; a fall in one's money income would necessarily mean some goods unsold in the market and a greater possibility of the goods being taken by those in whose hands there is a greater flow of money. One is tempted to feel that Dr. Hayek has exaggerated not only the proportion of the inflationary loans going for fixed capital but also has overestimated the consequences of stopping those loans. The idea of lack of capital receives its most pretentious form as a result of an alliance with the concept of forced saving—viz. as supplying an explanation of the trade cycle.

The fourth question is : *How is the capital thus generated or made available distributed in the productive organization ?* Obviously, profitability will determine this distribution. And so another realistic assumption is made in the frame-work of this so-called deductive theory : viz. that the conditions of round-about-production are not the same in all the industries. In some, the ratio in which labour and capital are combined is more elastic than in others. That is, in some industries this ratio can be changed in favour of capital without tampering with the marginal productivity of this factor of production and in others it cannot. Hence the former will be able to take loans from the banks at the cost of the latter which require a more drastic fall in the interest-rate to compensate the fall of the marginal productivity of the capital factor. Some industries grow, others dwindle !

Now Dr. Hayek would have us believe that 'he has proved' or is 'proving' or that 'it is self-evident and perfectly clear' and 'undoubtedly requires no proof' that

- (a) "A change in the amount of capital in society is identical with a change in the investment structure ;
- (b) an increase of investment is identified with a 'lengthening of the production process' ;
- (c) in the boom the period of production is increased ; and in the depression it is decreased."

"If the question were considered at all," writes Professor Frank H. Knight, "it would surely be immediately evident that in neither of the two senses discussed by Professor Hayek does the investment of more capital involve, still less is it equivalent to, a 'lengthening' of the time structure of investment and still less to a 'lengthening' of the production process. Moreover, there is no production process of determinate length, other than zero or all history¹." It can be shown that the 'round-about-process' may *increase* whereas period of production decreases². It is only necessary that the percentage of production cost relating to amortization rises. As somebody said : "for a number of industries the period of production does indeed decrease during the boom period."

The '*constitution*' then of the trade cycle as pictured by Dr. Hayek cannot be assented to. Nevertheless, it is interesting for us to see how he describes it using these concepts of a 'structure' and 'period' and one more : goods that are specialized for a particular use are called 'specific' and those that can be put to general use, 'non-specific'³.

The account of the trade cycle thus looked at is given below, as far as possible employing his own words :—

Contrary to what we have found to be the case when similar processes are initiated by the investment of new savings, this application of the original means of production and non-specific products, to longer processes of production will be effected without any preceding reduction of consumption. Indeed, for a time, 'consumption' may get on undiminished *after* the more round-about-processes have actually started, because the goods which have

1. The Economic Journal, March 1935, P. 78.
2. Dr. Hayek has two definitions for use at different places of this concept : thus an increase in the round-about-process may mean, (i) a greater flow of resources to the 'earlier' stages of production ; or (ii) actual increase in the number in which the process is divided.
3. "Prices and Production," P. 66.

already advanced to the lower stages of production, being of a highly specific character, will continue to come forward for some little time. But this cannot go on for long. When the reduced output from the stages of production from which the producers' goods have been withdrawn for use in higher stages has matured into consumers' goods, a scarcity of consumers' goods will make itself felt and the prices of these goods will rise. Had saving preceded to change to methods of production of longer duration, a reserve of consumers' goods would have been accumulated in the form of increased stocks, which could be sold and thus enable them to bridge the interval. But now there will be an involuntary reduction of consumption. This will be resisted by them, with the consequence that the price-margins will be again affected in just the reverse way, i.e. those more to the right will increase and those towards the left, decrease. Therefore, production of producers' goods will be comparatively less profitable and hence would be discontinued. In the new shifting of original means of production, there would be produced the unemployment of such as were employed on the extended schemes of producing capital goods. With reference to the unemployment question² "while the non-specific goods, in particular the services of workmen employed in those higher stages, have thus been thrown out of use because their amount has proved insufficient and their prices too high for the profitable carrying through of the long processes of production, it is by no means certain that all those which can no longer be used in the old processes can immediately be absorbed in the short processes which are being expanded. Quite the contrary; the shorter processes will have to be started at the very beginning and will only gradually absorb all the available producer's goods as the product progresses towards consumption and the necessary intermediate products come forward.....The final adaption will be further retarded by initial uncertainty as regards the methods of production".

Thus the capital created by the loans from banks employed labour which was discharged as a result of the non-profitability of employing that capital in co-operation with it. Since the original assumption was of full employment, we may expect in the long run to get even this unemployed labour back to work—may be in the "final stages" of production. But there are economic frictions which

1. Lecture III in the "Prices and Production."

2. "Prices and Production," P. 82.

3. This is psychological and non-monetary! However, a so-called deductive theory can include all this.

retard this. Hence the presence of unemployment. One wonders what part of unemployment can be traced, in a country, to sacking from enterprises engaged in producing construction goods. This proportion will vary it seems with the industrial advancement of a country as well as according to the stage of the cycle it is confronting.

V

It must have been obvious that Dr. Hayek's 'theory' of the trade cycle consists in piecing together a number of events which in themselves and in conjunction with one another are unique and not average or typical. Excessive credit creation; its use in getting producers' fixed capital; employment thus to labour on the fixed capital; the unprofitability as a decision by consumers to return to the old standard of living; consequent abandonment of the enterprise in constructive industries; the resultant unemployment in labour—such a sequence sounds well and orderly but bears but a slender relation to reality.

And what is Dr. Hayek's suggestion regarding the problem of escape from industrial fluctuations? He suggests two things—one of which is quite Spartan in nature. It is his suggestion of *liquidating* things during the depression period. The other is a plea for 'neutral' currency or Money. In all his references to money Dr. Hayek has considered it only to be a medium of exchange thereby emasculating it¹. Increase in money supply is considered by him to be justifiable in two cases: (i) "...any change in the velocity of circulation would have to be compensated by a reciprocal change in the amount of money in circulation....."² and (ii) "...changes in the demand for money caused by changes in the proportion between the total flow of goods to that part of it which is affected by money...should be satisfied by changes in the volume of money"³.

This "constant circulation" proposal has been criticized by Mr. Durbin in his 'The Problem of Credit Policy,' on the ground that capital accumulation increases the share of business transactions in the total circulation and therefore diminishes the consumers' income with deflationary consequences.

It might be said generally that the neutrality through constancy argument is faulty⁴. A divergence can take place

1. cf. Sraffa in *Economic Journal*, March, 1932.

2. "Prices and Production," 2nd edition, P. 124.

3. "Prices and Production," 2nd. edition, P. 121.

4. I for one am tempted to use money as an *active* good.

between the natural and market rates even under conditions of constant money supply¹. As Mr. R. G. Hawtrey has put it : ".....any objective other than the stabilisation of income of the consumers is consistent with a shrinkage of the consumers' income and therefore with deflation and unemployment²."

VI

Some aspects of the pedigree³ of Dr. Hayek's theory are examined in the following notes : 1. Sismondi's theories on Crisis ; 2. Equilibrium concept ; 3. Capital and Rate of Interest.

Note 1. J. C. L. Sismonde de Sismondi indicated a real point of departure when in 1819 he published his "New Political Economy", and professed entire severance from the Smithsian economics. His book contains four crude and not sharply distinguished explanations as to the origin of the crisis ; (i) That the commercial organization is at fault. Production is carried behind the screen for a metaphorical public and under a competitive illusion. (ii) That the income available for buying consumers' goods falls short of the value of goods sent to the market. The purchasing power available to absorb the produce of any year (say 1800), he contended, is drawn from the aggregate income collected in the preceding year (i.e. 1799). The faster the increase in 1800 (e. g. by introduction of machinery or growth of labour etc.) the wider will be the gap between the previous year's income and this year's output. (Sismondi lived among Italian agriculturists in the first quarter of the nineteenth century.) (iii) Abundance of capital rather than the demand of consumers determines the amount of production. This was a quaint form of the 'over-saving' theory. (iv) The masses do not wish luxuries so much as respite from toil. Improvement in the methods of production does not lead to the leisure of the working class but to the increase of the volume of products offered for sale.

"Prices are merely expressions of a necessary tendency towards a state of equilibrium; it is not permissible to reintroduce the old

1. An example may make this clear :—

Rs. 100 = Cost = Income. Let Rs. 50 be saved and Rs. 50 spent. Price of one unit of consumption goods is one rupee—for Rs. 50 was the cost of consumption goods. Suppose the ratio changes = Rs. 75 and cost of investment Rs. 25 cost of consumption goods. Saving therefore < Investment. The natural rate is higher than the market rate."

2. *Economica*, November 1935, p. 464.

3. The last is however analytical not historical.

Sismondian idea of the misleading effect of prices on production without first bringing it into line with the fundamental system of explanation¹." Not the over-abundance but the *lack* of capital plays prominent part in Dr. Hayek's depression. As to 'over-abundance' it cannot be supposed to be present in the "boom". The idea of shortage of income sufficient to absorb production is twisted and made to serve as the starter of the depression².

Note 2. The concept of 'equilibrium' runs like an underground stream in the writings of the Classical economists. The Physiocrats (1758) should have, if properly questioned, stated the "disturbance" to their economy as coming from the variation in size and use of the landlord's advances. Smith (1776) would have attributed it to any change either way in the division of labour. Von Thünen, would have us think that the distance from the central market and the durability of the article produced and the cost of transporting it were the determinants of equilibrium. It was J. B. Say (1803) who while enunciating his famous theory of openings for trade ("theorie des debouches") brought out the central concept in equilibrium analysis viz. the interdependence of economic quantities. Its development in the static branch was the work of Leon Walras (1877), Alfred Marshall (1879), and Vilfredo Pareto (1879).

Say obviously did not care to look into the fact that his proposition had greatest relevance only to a barter economy. He did consider the possibility of contemplating a different result after the introduction of money into an economy in this connexion, but did not pursue this line of inquiry. Dr. Hayek raised great hopes with reference to the much needed *extension* of equilibrium analysis. But realizations are always shorter than expectations.

Note 3. (a) In the introduction of Bohm Bawerk's "Positive theories of Capital" we find the suggestion that we should regard the capitalistic process of production as the *primary* concept and capital itself as *secondary*. "Capital is an integrated organic conception, and the notion that the investment in a particular instrument comes back periodically in the form of product, giving the owner freedom to choose whether he will re-invest or not, is largely a fiction and a delusion³." I may add that this delusion dates from the Physiocrats.

(b) Bohm's famous theory of capital does not however take into consideration this fact — his pre-occupation with time is

1. 'Monetary Theory and the Trade Cycle,' P. 85.
2. 'Prices and Production,' P. 79.
3. Frank Knight in the *Economic Journal*, March 1935, P. 83.

responsible for this. Bohm puts forward the doctrine that interest is the *agio* phenomenon which arises in the exchange of present against future goods. The proof is not convincing. Bohm knew that the difference in value between past and future goods which comprises this *agio* must originate, like all other exchange values, in their different *marginal utilities*. Now the two things necessary to determine the marginal utility of any good are: the supply of the good and the period of its consumption. *These two things are quite indeterminate in the case of future goods.*

(c) Further, the two incomes, the present and the future, can in no way be compared, much less on the basis of the present productive capacity. "There is a fundamental difference between the use of productive capacity to create more productive capacity and its use to create consumption income. The choice between the two uses is absolute. The new "future" income, when it comes to be created by the *new capacity*, can in no wise be imputed to the old capacity which created the new capacity..... No definite or finite amount of the absolute quantity of consumption services produced by a capital instrument or increment of capital can be connected with the activity used to create the capital¹."

(d) Wickseil suggested a problem and did not solve it when he wanted to investigate the relation of normal and equilibrium rates of interest to the value of money. Natural rate meant for him the rate of interest in a barter economy. He gave another definition: the rate which will in a money economy, equate the demand for loan capital with the current supply of voluntary savings. Mises offers another definition: The rate that would be determined by the supply and demand of actual capital goods if lent without the mediation of money; or that determined by the *whole economic situation* at the time. Meade indicates it as follows: "A neutral money system is one which simply interprets the decisions of individuals.....without by its own action or inaction making the *effects* of such decisions different from what they would have been in a non-monetary economy. If population is constant one which maintains or keeps the final incomes constant is the equilibrium rate of interest."

(e) Some of the following facts are likely to escape attention:

- (1) Each category of capital has its own particular problems and its own sets of prices;

1. F. H. Knight in *Economic Journal*, August 1934, P. 274.

- (2) There is a veritable family of interest rates in an economy ; the Central Bank rate may be the *patria potestas* among them ;
- (3) There would be a rate of interest in a society in which no new capital was being formed ;
- (4) even, in which, the capital was not productive ;
- (5) or all the borrowing was for consumption.

Dr. Hayek while discussing the case of voluntary savings and fluctuations seems to have meant 'gratuitous' when he used 'voluntary'. It is quite possible that 'voluntary' savings may not be 'gratuitous'. But this omission of the rate of interest in this case enables him, by its very active presence in the situation of inflationary loans, to emphasize the contrast between them !

S. V. SONNI.

SUMMARIES AND ABSTRACTS OF THESES SUBMITTED FOR THE M.A. DEGREE

Economics of Transport

The history of the development of modern means of transport is the history of modern civilisation. The social and economic organisation of the world as we now witness it would have been impossible but for the phenomenal achievements of man in bringing together remote corners of the world into close contact by making exchange of goods and services easy and prompt.

The economic progress of India has a good deal to do with the progress in the sphere of transport developments, and our future growth will also be closely bound up with the way in which this important activity is developed in the country. In view of this the need for a systematic study of the transport problems of the country is obvious.

In spite of this the study of transport, its principles and problems, the experience of other countries and the difficulties of our own, and the place of transport in the economic life and policy of the country have not found adequate place in the University courses in Economics or Commerce. In the University of Bombay the student reading for the B.A. or M.A. degree in Economics may know only a smattering of the subject, and can afford to neglect it. In the B.Com. degree course, Transport is included among the optional group of subjects that a candidate may select. Though this has been on paper for now over twenty years, the Sydenham College of Commerce, the only College of its kind in this Presidency has not made provision for teaching the subject. It is high time that those concerned take adequate steps to see that the study of Transport has a proper place both in the Economics and Commerce courses in the University.

In spite of this, it is gratifying to note that some useful research work in several important problems in Transport has been done in the University School of Economics and Sociology. The following three candidates wrote theses on the subjects mentioned against their names :—

- I. Mr. D. N. Marshall : The Indian Transport system :
Its economic sufficiency and
geographical distribution. (1930).
- II. Mr. K. O. Badheka : Transport facilities in Kathiawar.
(1932).
- III. Mr. R. D. Tiwari : Railway rates in relation to Trade
and Industry in India. (1933).

I

Mr. Marshall's thesis is a study of the inland means of communications and aims to test their economic sufficiency and geographical distribution in relation to the country's demand for transportation as evinced in its trade, industry, and agriculture. It mainly attempts to relate the supply of available transport facilities offered by the different means of communication, to the demand for them arising from the economic movements in the country. The work is divided into three parts. Part I attempts to determine statistically the aggregate sufficiency of the system. Each of the chapters surveys statistically the railways, roads and inland waterways, respectively, with a view to test their sufficiency, and the criteria employed are two. One is comparative, wherein the position of other countries as to the facilities they afford relative to their own economic needs forms the basis of comparison. While the other is provided by the country's intensive demand or need for such transport facilities as can be measured from its extent of population, area, trade movements, industrial demand and agricultural needs. In part II an attempt is made to survey the geographical distribution of the inland transport system varying the economic points of view each time. For instance, in chapter VI, the external land movements or the viewpoint of trans-frontier trade movements is taken to see how far they are facilitated or hampered by the existing transport lines. In the next chapter, the external sea movements are dealt with so far as they give rise to internal movements, and from the viewpoint of sea-borne trade, the hinterlands of the different ports are determined and analysed as to the extent and location of economic movements originating therein. Existing transport lines are then studied in relation to these movements to see how far their distribution is in consonance with the demand for them. In the same way chapters VIII and IX deal with the internal trade movements on the basis of provincial blocks ; and the economic geography of each of the provinces is analysed with reference to the influence of physical and climatic features, distribution of population, agricultural activity, industrial and trade movements—internal as well as inter-provincial—and a survey of the existing transport lines is then undertaken to see how far these movements are eased or hampered. In the last part, conclusions reached in the former two are strung together, leading to a comprehensive and constructive survey, wherein each of the means of communication is treated as to its future reconstruction, which can make it more effective than what it is. The schemes for such reconstruction affirm the need for co-ordination which at many points in the body of the thesis emphasises itself, and a special

chapter is devoted to co-ordination, wherein the experience of some of the leading countries and the practice prevalent therein have been utilised to form a constructive scheme for India. In conclusion, the question is asked as to what has been the function of the Indian transport system till now and what it should be in the future in the light of the experience of other countries. The answer is that the Indian transport system should be treated as a second line of economic protection.

II

Mr. Badheka has attempted an intensive study of the transport system in Kathiawar as a whole. The singling out of a province for this study was not, however, accidental. It was selected because it presents problems of an essentially different character from those in other parts of India. The province is ruled by a number of internally autonomous states, about 150 in number, having varying resources, power, area and population. The railways, ports and roads are owned, managed and worked by some of these states with the result that right from their inception they have given rise to problems peculiarly their own in matters of policy, finance, administration and working. The Commissions and Committees appointed to investigate transport problems in this country have made only a passing reference to the problems of transportation in Kathiawar. The present study therefore, is an attempt to fill up the gap.

The work is divided into four parts, Part I deals with railways, Part II with ports, Part III with roads and Part IV with the co-ordination of the entire transportation system. The study of the railway problem covers a period of about fifty years. In the first chapter the birth pangs of the railways in the province have been traced, while in the second chapter the railway construction of different states, their economic necessity and adequacy have been studied. The third chapter deals with the unification of gauge in Kathiawar, adoption of metre gauge, benefits of unification and the inter-railway competition it led to. Chapters IV and V deal with questions of organisation, management and control of these Indian State railways under a system of joint management before 1911 and their separate working since then. In chapter VI is portrayed a plan for the voluntary amalgamation or joint working of these railways. The three succeeding chapters deal with the financial side of the railways and their working results as business enterprises. These analytical chapters have been made comparative wherever possible. Chapter X deals with the rates and fares of railways and brings to relief the striking features of the rates policy

pursued by the Kathiawar railways. Chapter XI deals with the co-ordination of railroad and steamship services.

In three succeeding chapters in Part II of the work port problems and ocean transport have been studied. In chapter XII the account of Kathiawar as a maritime province both in ancient and mediaeval history has been traced and its commercial relations with various countries of the ancient world, the nature of its sea-borne trade and its prosperity have been briefly noticed not merely for their historical importance, but also to set a proper perspective for later contentions that these ports have greater potentialities and that their present stunted growth is due to neglect or artificial restrictions. In the next chapter a few more important ports in the province which recorded a remarkable growth during recent years have been studied in detail. In chapter IV the position of Kathiawar as a whole in ocean trade, transport and shipping is summarised, and the burning problem of maritime customs of these ports has been studied in broad aspects, and the present anomaly of the relations between British India and Indian maritime states has been pointed out, indicating at the same time the method of putting a stop to such a practice and evolving a sounder system under the Federation.

In the next two chapters in the third part the problems of road transport in the province have been studied. Chapter XV discusses the present development of the road system in Kathiawar, the financial and administrative difficulties that faced such a development in the initial stages, the defects and inefficiency of the present system, the need for further road development for providing sufficient and efficient means of communication to the village community and the ways and means of financing the schemes. The next chapter is a review of the economics of motor transportation. There are many restrictive factors on motor transport development in the province for want of good roads, and the jurisdiction of various states with varying policy, but in spite of this the motor bus has proved a serious rival to railway services and the menace is rapidly increasing. The last chapter emphasises the necessity of transport co-ordination.

III

Mr. Tiwari has studied the railway rates policy with special reference to trade and industry in India. This thesis is divided into two parts. Part I is an attempt to provide a theoretical and historical background and to pave the way for a more comprehensive and scientific analysis of the rates policy in its present working. The first chapter is devoted to the general discussion of the transportation

system in its varied aspects and the place of railway transport in the general transport system. The theoretical basis of railway rates and the essential elements which have to be constantly kept in view and properly weighed by those responsible for rate making, and the lines on which the rate policy should be framed, is the subject matter of the second chapter. These two chapters enable us to appraise the nature of the railroad transport industry and the basic principles of a scientific freight policy. The following two chapters contain an historical review of the Indian railway policy in its main phases: the drawbacks in its early construction and working are noted and the financial and rates policy carefully studied.

Part II examines the present rate structure objectively. The position and prospects of selected industries are studied with special reference to railway rates. The more important and representative industries have been selected and studied so as to give a complete idea of the railway rates policy as affecting the Indian industries and commerce in general. The industrial background in each case has been carefully presented and the demand and supply of railroad transport facilities fully discussed. The direction of the movement of traffic in its geographical setting has been emphasised with a view to show how intimately transport economics and geography are related. Indeed, the study of railway rates without its geographical background is well nigh impossible. Especially in a study like the present which treats of the collection of raw materials and the marketing of finished products of different industries, the geographical factors of location and distance are basic. Further, wherever possible the present rates have been compared with those of a pre-war year so as to bring out the relative position of the rates policy.

This method of approach has been applied to nine selected industries, the position of each of which is studied in detail to determine the incidence of railway rates on the cost of production of the industry and therefore on its ultimate success. The co-operation of those in practical touch with the industries on the one hand and of some railway authorities on the other was obtained to study with accuracy this highly complicated problem. Mr. Tiwari has succeeded in establishing several useful and interesting conclusions.

Reviews

Considerations on the Present Evolution of Agricultural Protectionism. (League of Nations, Geneva)

(C. 178, M. 97. 1935. II B)

The subject matter of this Report is the 'evolution' of agrarian protectionism, and the treatment is as under: (1) "a few observations of a general character"; (2) Sir Frederick Leith Ross' note on agricultural protectionism in Europe—in the Post-War period; and (3) another note on "the general evolution of Agriculture at the end of the nineteenth century and before the World War, in relation to the growth of agricultural protection".

The need for such an inquiry is evident. Agriculture forms the main occupation of something like two-thirds of the world's population. Further, agriculture compared with industry is peculiarly vulnerable as an economic activity. Finally, significant changes in the international and national settings of agriculture during the post-war period render all the more urgent an examination of the various ways of assisting agriculture.

Within the covers of this Report, therefore, one expects to find information re. the following points: *definition* and *scope* of the phrase 'agricultural protectionism'; the *purpose* and *forms* of agrarian protectionism, and finally, discussions regarding the international price disturbances that were induced by the adoption of protection to agriculture and their consequences.

Such an approach to the contents of the Report reveals at the outset certain shortcomings in it: (1) Agrarian protectionism has been taken largely to mean—this is so at least by implication—such assistance as is given *via* the tariffs; (2) there is a very large if not an exclusive emphasis on the growth of protection to European agriculture—thus narrowing the scope of the treatment unduly, and generating a misleading suggestion that non-European agriculture has not or does not require protection.

The 'essential purpose' of agrarian protectionism has been defined as: "to keep home prices at a minimum level regarded as remunerative"—i.e. to make agriculture pay itself (page 11). The *forms* of protecting agriculture are to be found in this sentence: "—Duties higher than world prices, ever stricter rationing, the progressive reduction to close upon vanishing-point of the proportion of foreign products admitted in the various preparations,

bounties for production, export bounties, 'Schemes', monopolies and various other forms of planned economy" (page 6). Another thing that should be noted is that the 'evolution' of protection to agriculture, besides being confined to Europe, is turned topsyturvy. Out of three sections in which the Report divides itself, the first is a plea for *moderate* protection to agriculture; the second is a review of conditions affecting agriculture between 1920 and 1934; and the third is a part of the economic history of Europe between 1870 and 1913. In the interests of history and clarity it might prove useful to read the booklet in precisely the reverse order in which it is arranged.

The main intention of the Report is to plead for moderate protection to agriculture, which means proving in the first place that agriculture requires protection and in the second place that this protection must be trimmed to moderate limits. This is done in the Section on 'general considerations'. That agriculture needs protection is convincingly proved by various arguments: on economic grounds—affecting the nature of supply and demand of agricultural production; and for 'political and historical and psychological reasons'. Moderation is advanced on the ground that *in the interests of the protected agriculture itself, overprotection* would lead to its undoing. Thus overprotection to agriculture in a particular country would not only complicate matters in some other agricultural country; it would also lead to internal disharmony with the industrial activity of the country; and ultimately would leave that country's agricultural system crippled.

The question then is, what is moderate protectionism in agriculture? On page 8 we are told: "the only practical aim which we can set before us is to determine *what are the limits* which should be placed on this form of mutual aid in order to prevent it from becoming harmful to the normal development of international economic relations and to ensure that it shall not involve any loss for the nation which practises it or, ultimately for the farmer himself". A castle of words! Nowhere in the booklet are we given any idea of those 'limits'. Afterwards we are told twice about "the maintenance of a normal current of agricultural imports on the part of the industrial countries is in keeping with the true interests of the nation as a whole and of the agriculturists in particular". The existence of 'unduly restrictive quotas' is 'incompatible' with such a policy. But what exactly is 'unduly restrictive'? We are nearer the earth in the sentence following: "Certain countries which import large quantities of agricultural products prefer to afford their agriculture what appears

to them equitable assistance by means of *direct subsidies*, the funds for which are provided by duties sufficiently moderate in themselves not to cause any undesirable rise in the foodstuffs within the country". (page 13)

The most valuable portion of the Report is the contribution of Sir Frederick Leith Ross. His conclusions stated succinctly on page 35, are based on a careful study of statistics relevant to the topic. This note read in conjunction with some such book like "World Agriculture, an International Survey" will supply all the information usually demanded by the student of international agricultural problems in general and state help to agriculture in particular.

Shridhar V. Sohoni.

The Birth of the Middle Ages (395-814). H. St. L. B. Moss.
(Oxford University Press). 12/6 net.

The four centuries between the death of Theodosius and that of Charlemagne still contain the most obscure portion of European History. Even to the advanced student the period of the passing of the ancient world into the mediæval is bristling with difficulties and to the general reader it is still practicably unknown. This book will appeal to both classes, for a deep knowledge, founded on the latest research, is accompanied by a judicious elimination of the non-essential and the result is a survey of the whole wide field of Rome in decline which is both interesting and accurate, in fact a good example of the new technique of historical writing.

Like all modern Scholars, Mr. Moss rejects the catastrophic view of the passing of the Roman World and the main argument of the book is that there was far more continuity than was generally supposed in the Dark Ages. This development of the evolutionary theme on the political, administrative, religious and economic sides is very sound, but perhaps the most interesting portion is that devoted to the evidence given by the art and literature of the period, dismissed by those imbued with the strict classical tradition as being barbarous and worthless in Western Europe and imitative and tediously theological in Eastern. These are shown as a result of more critical and also more sympathetic investigation, in a much more favourable light and bear out the contention of gradual evolution.

The character and achievements of the Byzantine Empire receive adequate recognition and when dealing with Islam, which shared with Eastern Empire the position of being the dual repositories of power and civilization, Mr. Moss gives us some of his best

chapters. Earlier writers, partly from ignorance and partly as a result of mediaeval prejudices persisting through the ages, seldom rated Islamic institutions at their true worth or recognised how much there was in common between Christian and Muhammadan culture, or how great was the intercourse between East and West. Taken altogether this is an admirable survey of an enormous field and one which makes clear how the transition in Europe from the Roman Imperial stage to the mediaeval was brought about in both her Eastern and Western parts. The maps and illustrations are excellent and there is an adequate bibliography.

Decay of Indian Industries. By P. R. RAMCHANDRA RAO.
(Bombay, D. B. Taraporewalla Sons & Co.) Rs. 2.

In this book Mr. Ramchandra Rao has attempted to review what he calls "the decadence of our industries", or as Mr. Kumarappa puts it, he "feels the pulse of the dying industries of India." With this object in view the author divides his study into seven chapters to which is appended a note on the All India Village Industries Association.

In the introduction, Mr. Rao explains the purpose of his study. He realises that the decay of Indian industries is not due to the atrocious measures resorted to by the servants of the East India Company as is popularly believed, but that the decay which had already set in during the later part of the Mughal Rule was merely accelerated by the step-motherly treatment of the Company and its agents. One feels that in the absence of the East India Company our industries would not have fared better due to improved technique of industrial production ushered in by the Industrial Revolution, unless our manufacturers had promptly adjusted themselves to the changed circumstances. Cheap machine-made British goods aided by preferential tariffs and cheap railway rates from the port towns to internal consuming centres flooded the entire Indian market and soon succeeded in eliminating the Indian producers.

The author has devoted five chapters in reviewing this decay. This according to him was his task. As such this book is of little interest to the student, because many authoritative works on the subject are available. The last chapter is really the most important part of the book. The author raises very important issues but has not done adequate justice to them. This chapter, according to the author, is but a sequel, an after-thought and a fitting culmination to the inquiries into our industrial decadence. We feel this ought to have been the main theme of the book rather than a mere after-thought. Our industrial achievements

and the pitfalls of the subsequent decadence have been studied with sufficient clarity and authority ; so what we need to do is a concrete scheme of industrial reconstruction based on a critical study of our economic history which would help the business community and the State in moulding the course of our industrial organisation. It is the duty of the economist to place the conclusions drawn from his critical analysis of facts past and present in easily intelligible form before the public, suggesting the future course of reconstruction on sound lines, and it is in this connection that chapter seven is important.

The thesis of this chapter according to the author is, " that our industrial future lies in the resuscitation of our decadent industries in the increasing opportunities of employment they afford to our starving millions." This is a laudable desire to which no student of economics will demur. But the difference of opinion arises as to the nature and methods of resuscitation. The decadent industries should be re-organised essentially on modern lines taking full advantage of improved technique of production. Efficiency and economy should be the watch-word of our industrial revival. In his zeal for supporting Mahatma Gandhi, the author has over stressed the case against mechanised production and added little to our knowledge.

R. D. T.

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[PART 5

OBSERVATIONS ON SOME SPECIES OF VOLVOX FROM POONA WITH THE DETAILED DESCRIPTION OF VOLVOX POONAENSIS

by

V. V. APTE

FERGUSSON COLLEGE, POONA

(*With 7 Text-figures and 14 Plate figures*)

CONTENTS

Introduction,—The Volvox of Poona (1) General Characters
(2) Asexual Reproduction (3) Sexual Reproduction (4) Identification,
—Volvox dissipatrix,—Volvox prolificus,—Volvox carteri.

INTRODUCTION

Except the Volvocales from South India described by Iyengar (9) practically nothing is known about these interesting Algae from any part of India. It is, therefore, attempted in this paper to record some observations on some species of the genus Volvox collected from Poona and its neighbourhood. Two of the species described are abundantly found in Poona which is situated about 2000 feet high from the sea-level on the eastern slope of the Western Ghats. The other two species have been so far found at the hill forts Sinhgad and Purandar the heights of which from the sea-level are more than 4000 feet.

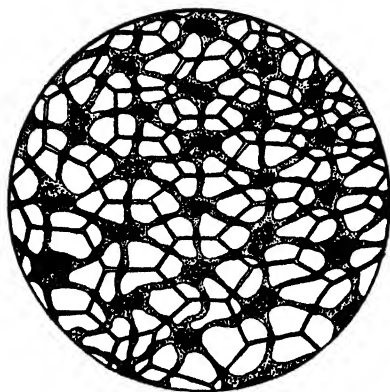
These species have been found in abundance in freshwater ponds of these places. They occur in association with water-plants like *Lemna*, *Spirogyra*, etc. They are generally confined to clear water and scarcely occur in turbid or muddy water. During and after the annual rains (July to December) they occur in most of the pools with clean water. In dry parts of the year the volvox is forced to go through a period of rest.

A NEW SPECIES OF VOLVOX FROM POONA

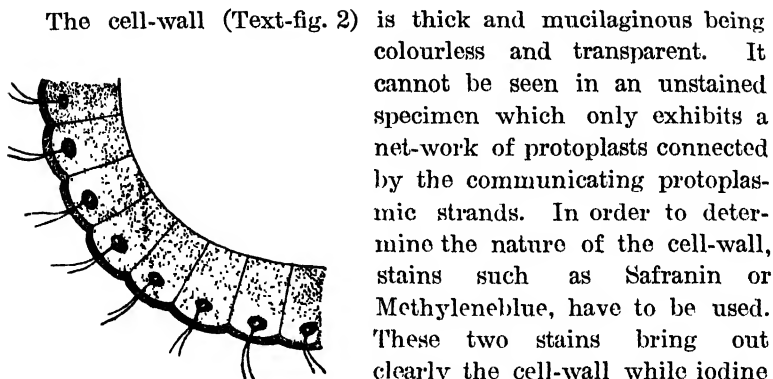
(1) GENERAL CHARACTERS

The plant appears to be encased in a colourless mucilaginous sheath which is smooth and slimy. With the help of its cilia the plant rotates about its longer axis and moves in various directions in water. The cells of the plant are very close together at its posterior part, while at the anterior they are comparatively loosely set. Though the exact distance between any two neighbouring protoplasts is not always the same, from a number of measurements on fresh material it can be said that the average distance between two protoplasts in the posterior part varies from 2μ to 3.5μ , while in the anterior part it is as much as 4μ to 5μ . The plant is slightly egg-shaped and hence the mean diameter is always measured. The diameter of a plant varies between 400μ and $1,000\mu$, while the number of cells in a plant varies between 7,000 to 10,000.

Each constituent cell of the plant is more or less pentagonal or hexagonal in outline (Text-fig 1; Plate III, fig. 7). The diameter of the protoplast varies between 5μ and 6μ , although in some cases it is as long as 8μ . The protoplast is almost stellate in surface view on account of its giving off from its sides 5 or 6 clearly visible protoplasmic strands to the adjoining cells which in turn have similar ones to meet them. The side view of each protoplast is slightly ovate with the upper part conical and the protoplasmic strands are seen to be attached to the sides.



Text-fig. 1—Diagrammatic surface view of *Volvox poonaensis*.



Texti-fig. 2—Diagrammatic lateral view of the wall of *Volvox poonaensis*.

The cell-wall (Text-fig. 2) is thick and mucilaginous being colourless and transparent. It cannot be seen in an unstained specimen which only exhibits a net-work of protoplasts connected by the communicating protoplasmic strands. In order to determine the nature of the cell-wall, stains such as Safranin or Methyleneblue, have to be used. These two stains bring out clearly the cell-wall while iodine stains the nucleus and the cell-contents fairly well. The cell-wall consists of three layers; the outer, the inner and the middle one. The outer layer is the original cell-wall—called middle lamella; inside this is the thick mucilaginous middle layer, while the inner is thin and membranous. The thickness of the cell-wall is mainly due to the mucilage mass of the middle layer which is not uniform all-round. The cell-wall is thinnest on the peripheral surface, being perforated in the centre of the wall to allow the two cilia to come out. It is much thicker on the sides but it allows the protoplasmic strands to communicate with the adjoining cells. On the basal side, the cell-wall is thickest. Like the external envelope of the plant there is also formed the internal thick mucilaginous envelope by the united internal walls of the cells. In a stained preparation it appears to form an inner circumferential zone of the plant. Thus the radial axis of the cell exceeds the transverse one which on average varies between 10μ and 16μ . In a stained specimen the surface of the plant looks like a plate of hexagonal or pentagonal cells arranged just like the pavement of the floor.

The nucleus (Text-fig. 1) is very conspicuous and occupies the organic centre of the protoplast. At its basal part is an irregular chloroplast in which lie two or four pyrenoids. There are a few contractile vacuoles in the protoplast. A conspicuous red eye-spot is also present in the upper part of the protoplast. The eye-spot is large and prominent in the cells of the anterior end and gradually diminishes in size towards the posterior end, while in some of the posterior cells it is almost absent.

The cilia are the organs of locomotion of *Volvox*. Each cell (Text-fig. 2) has two cilia attached to it at its peripheral end. In a

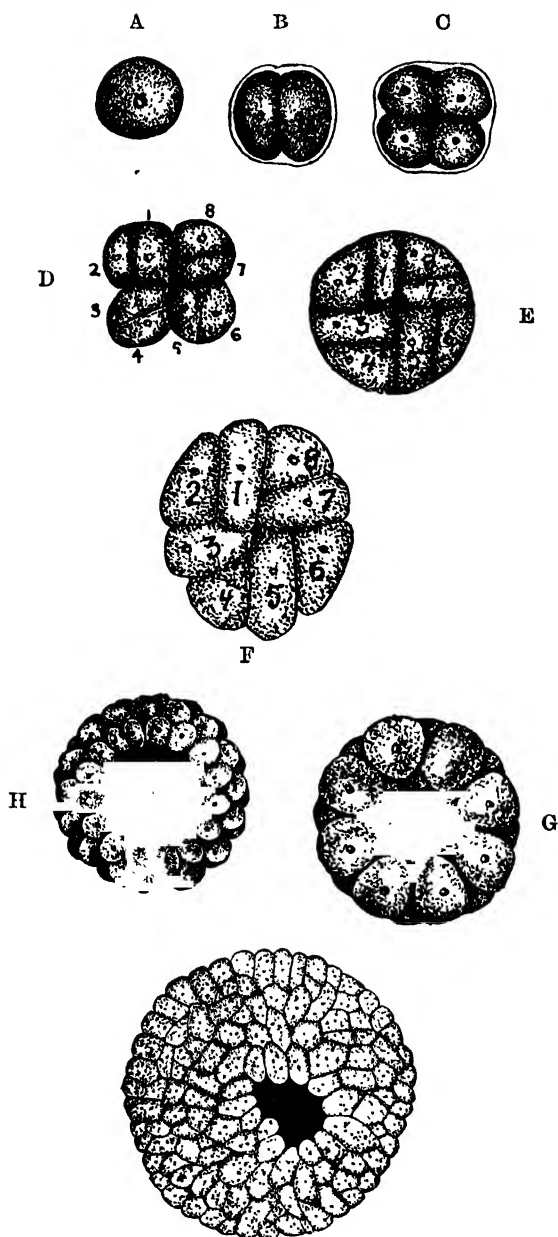
Volvox where daughter colonies or sexual reproductive bodies have been formed the cilia of the cells do not move actively but the plant as a whole remains more or less stationary. Ultimately with age the movement stops and the plant disorganises.

(2) ASEXUAL REPRODUCTION

Asexual reproduction is carried out by the formation of gonidia which finally develop into daughter colonies. This gonidial formation is generally associated with conditions suitable for luxuriant growth. Each gonidium (Text-fig. 3, A) is developed from a single vegetative cell. Many such cells are differentiated but only a few develop to form daughter colonies. Each gonidial cell first divides along its longer axis into two cells in a vertical plane; the two daughter-cells (B) again divide along its longer axis into two, the vertical plane of this division being at right angle to the previous plane of division. Thus four cells are formed (C). Each of these four cells again divides in a vertical plane into two unequal cells as the plane of division is parallel to one side of the cell and cuts the other side at a point a bit removed from the centre. This division is symmetrical in all the four cells and it results in the formation of four cells—shorter and broader and other four cells—longer and narrower (E). The former lie removed towards the circumference while the latter extend from the centre to the circumference. These longer cells meet at the centre and thus the connection of the shorter cells with the centre is cut off. The four narrow cells meeting at the centre form the well-known *Volvox*-cross, while the other cells are placed in the four angles, their angular sides being directed towards the centre.

These eight cells divide again into sixteen cells (Text-fig. 3, F). This plate of sixteen cells then becomes slightly concave and by further divisions of the peripheral cells this concavity deepens and assumes the form of a shallow cup. By further growth the mouth of the cup becomes smaller and thus a hollow daughter colony is formed with a small aperture at one end (H and I). This end is directed towards the circumference of the mother plant.

Before the daughter colony assumes the final form its hollow body is turned inside out so that the anterior ends of the cells that were first turned towards its cavity are directed towards the exterior, and the posterior ends are directed inwards. The small opening is then closed and a daughter colony is fully formed.



Text-fig. 3—Stages in the development of a gonidium. A, one-celled ; B, two-celled ; C, four-celled ; D, E and F, eight-celled stages ; G and H, later stages ; I, young colony before coming out.

The cells of the daughter colony develop cilia and with their help it is seen moving inside the mother plant. Many a times some of the cells of the daughter plant appear slightly different as they form the initials of the grand-daughter colonies. Although these rudiments are seen, actual grand daughters or the sexual reproductive bodies have not been observed in any of the daughters while still within the body of the mother.

Although many initial cells are found in a plant the number of daughter colonies is generally 8, but very often less; rarely it is 12 or even 16. The daughter plants are in different stages of development and possibly the space inside the mother plant sets a limit to the number of daughter colonies finally formed.

With the adult daughter plants the mother plant becomes rather sluggish. It is observed that daughter colonies come out by breaking open the mother plant at different places which afterwards disorganises and dies. The average colony inside the mother plant is 250μ in diameter, but after it comes out and moves as a free plant the size is increased and it varies between 600μ and 1000μ . This increase in the size of the plant is not due to the increase in the number of cells that go to constitute it; it is rather due to the increase in size of the individual cells. The cell-walls, which were very thin when the plant was young and inside the mother plant, gradually become thicker and thicker by the deposition of a mucilaginous substance. The protoplasts become naturally separated from one another, though they remain in communication by means of their strands. That the number of cells does not increase with the increase in size of the plant can be proved by the following calculation.

The diameter of the daughter colony is 250μ . The area of its surface is therefore $4 \times \frac{2^2}{7} \times 125^2 \text{ sq.}\mu$. The diameter of the cell varies from 5μ to 6μ . The area of the cell surface is $\frac{2^2}{7} \times \frac{5}{2} \times \frac{5}{2}$ when the diameter of the cell is taken as 5μ .

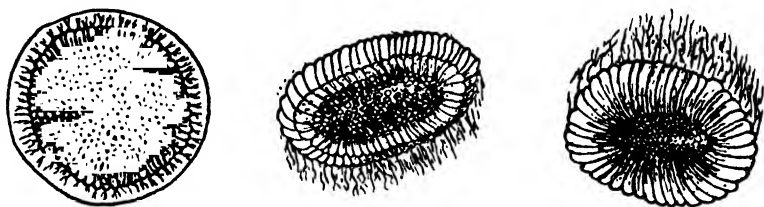
The total number of cells is therefore $\frac{4 \times \frac{2^2}{7} \times 125 \times 125}{\frac{2^2}{7} \times \frac{5}{2} \times \frac{5}{2}}$,
i.e., 10,000

If the diameter of the cell is taken as 6μ the number comes to 7,000. Thus the number of cells found in a young colony varies between 7,000 to 10,000; in other words, it is the same as that of the adult colony.

(3) SEXUAL REPRODUCTION

The daughter colonies of successive asexual generations gradually diminish in size. Then at the sexual phase the plant becomes considerably smaller as can be seen from its diameter which varies between 400μ to 500μ , as against 600μ to $1,000\mu$ in the vegetative phase. The shape and other characters of the colony remain the same.

The Volvox, under consideration, is monœcious and protandrous¹. The sexual bodies are formed towards the posterior part (Plate II, fig. 4). There are generally 5 to 6 antheridia, rarely the number is 8. The antheridium is formed from a single cell. A vegetative cell first loses its cilia and gets bigger at the cost of the surrounding cells which on that account appear smaller. This



Text-fig. 4—Three views of the antheridium of *Volvox poonaensis*.
 $\times 820$ (approx)

formation is in no way different from that of the gonidial formation. The cell divides and subdivides and a group of cells is formed within the original cell-wall. The number of cells normally formed in an antheridium is about 128. Each cell then functions as a spermatocyte and gives rise to a sperm. The sperm is 5μ to 6μ long, greenish yellow in colour and has two cilia. These cilia are independently developed and not derived from those of the original cell.

The antheridium has the form of a flattened disc, a few cells thick, in which the sperms are so arranged that their heads point towards the centre of the disc, while their tails radiate from the rim and give the antheridium a ciliated appearance (Text-fig. 4). The antheridium is 35μ in diameter and greenish yellow in colour. The mature antheridium leaves its place as can be seen from the blank spaces in the colony. Sperms were seen moving through the matrix but the actual fertilisation was not observed.

1. Stray cases in which the plants had within its body daughter plants in various stages of development and also many oogonia or oospores have been observed.

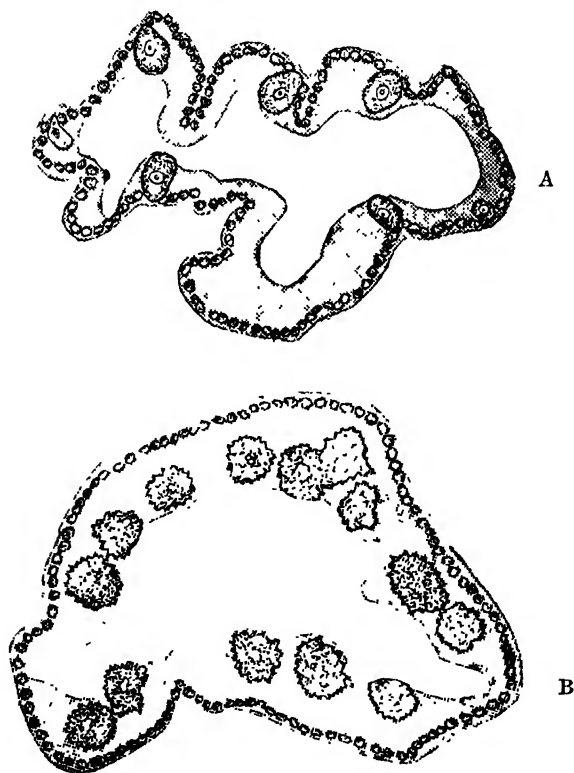
Like the antheridia the oogonia are also formed towards the posterior part of the plant. The initial cells (Text-fig. 5) lose



Text-fig. 5—Formation of reproductive cells in *Volvox poonaensis*.

their cilia and become very large apparently at the cost of adjoining cells. It is not unusual to find a few cells united into one large cell which then becomes an oogonium. The oogonium (Text-fig. 6 A) is pear-shaped with its apex a little drawn out and directed towards the circumference beyond which it slightly projects

while the broader base hangs down into the cavity of the



Text-fig. 6—Sections of *Volvox poonaensis* showing oogonia and oospores $\times 200$.

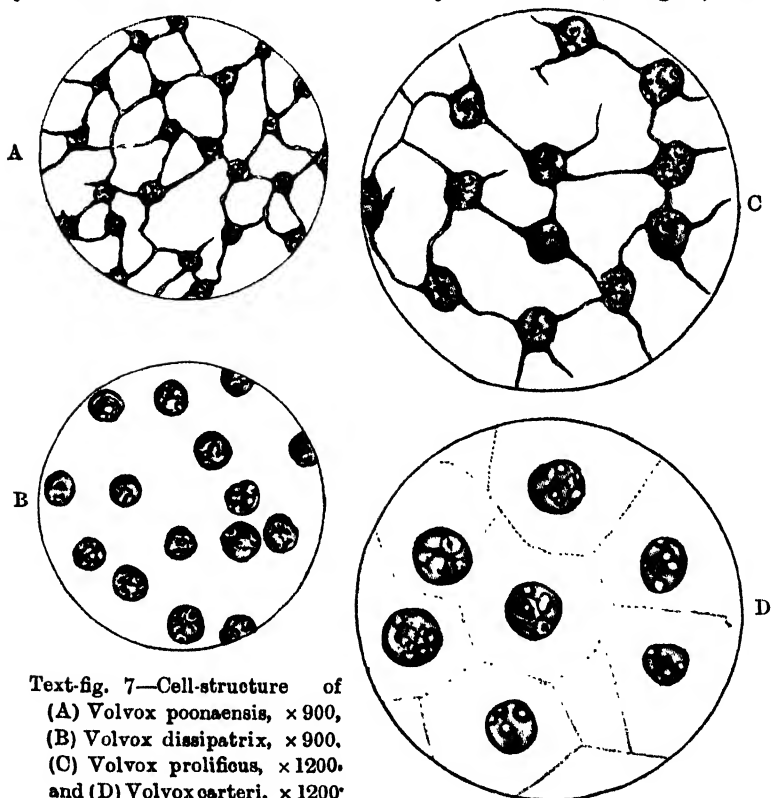
plant. The oogonium is many times the normal vegetative cell in size. Its transverse diameter often measures from 18μ to 22μ . Along with

these changes the red eye-spot disappears from the oogonium and it becomes roundish in form. There are generally 80 to 120 oogonia in a colony. This number often reaches even 200. All these female gametes lie embedded in the peripheral rim of the mucilage where they are seen even after fertilization. In the *Volvox* under consideration fertilization takes place in the circumferential zone and not in the cavity (Text-fig. 6B). More work is necessary to say exactly whether there is cross or self-fertilization.

The ripe oospore (Plate 4, fig. 8) has a thick outerwall which is beset with a number of short conical projections which are 8μ long. Such a kind of wall is called sub-stellate. The oospores are at first green but the colour soon changes to brown and then blackish. The mother colony soon decays and the free oospores sink to the bottom.

(4) IDENTIFICATION

The genus *Volvox* has been differently divided into species by different authors — Shaw, Playfair, Pascher, Engler, etc.



Without going into the merits or demerits of their bases of

classifications the writer has followed the classification given by Engler in the main, while for the specific details he has referred to Pascher's description and also to Iyengar (1933) who has described some 8 species from South India. Engler has given 17 known species of *Volvox* from all over the world. These have been placed by him into six groups. Out of these six groups only in the first the plant is possessed of thick communicating bridges while in the second these bridges are present but are hair-like and in the last four the bridges are either absent or invisible. It has already been mentioned that thick communicating bridges are present in the *Volvox* of Poona (Text-fig. 7, A) and that the inner wall of each of its cells is very distinct. It, therefore, comes under the first group namely *Euvolvox*.

Further, according to Engler six species are recognisable in this group viz. (i) *V. globator*, (ii) *V. perglobator*, (iii) *V. rousseleti*, (iv) *V. merrillii*, (v) *V. barberi* and (vi) *V. lismorensis*. The *Volvox* of Poona being homothallic can stand comparison with only those species out of these six, that are themselves homothallic and, therefore, (i) *V. globator*, (ii) *V. merrillii* and (iii) *V. barberi* are the species that are worth comparison.

	<i>V. merrillii</i>	<i>V. globator</i>	<i>V. barberi</i>	<i>V. of Poona</i>
Diameter of the plant	asexual 1000 μ sexual 90 μ to 750 μ		1000 μ , 90 μ to 760 μ	600 μ to 1000 μ and 400 μ to 450 μ
Number and size of cells	17000, 12000 4 μ to 8 μ	20000, 1500 to 10000 3 μ to 5 μ	31000, 30000 3 μ to 5 μ	10000, 7000 5 μ to 6 μ
Number and size of gonidia	8 or less	8 180 μ to 200 μ	8 or less	4 to 16 200 μ to 250 μ
Number and form of antheridia	Few Spherical	6 to 15 Spherical	Few Spherical	5 to 6 Flat
Number of oogonia	120	20 to 64 but generally 30	224	80 to 120 sometimes even 200
Size of oospores and length of spines	36 μ to 42 μ 11 μ	40 μ to 45 μ 46 μ to 56 μ	35 μ 3.5 μ to 5.5 μ	32 μ to 35 μ 8 μ

A glance at the table given above will clearly show that the *Volvox* of Poona differs from the other three homothallic species mentioned above as regards its size, the number of its cells, the diameter of each cell, the number and size of gonidia, the number and form of the antheridia, the number of the oogonia, the size of the oospores, the nature and length of the spines on the oospore and such other important characters. The minimum number of cells in *V. merrillii* and in *V. barberi* exceeds the maximum number of cells in the *Volvox* of Poona. The antheridia are spherical in all the three species while they are flat and disc-like in the *Volvox* of Poona. The spines in these forms are quite dissimilar to those found in the *Volvox* of Poona and also their lengths differ. The number of oogonia in *V. merrillii* is 120. in *V. globator* commonly 30 and in *V. barberi* 224, while in the *Volvox* of Poona they are 80 to 120 and at times even 200.

As the *Volvox* of Poona differs in majority of characters from the above species, it deserves to be recognised as a distinct species and the author has called it *Volvox poonaensis*.

VOLVOX DISSIPATRIX (SHAW)

This alga was collected from the fort Sinhgad in 1934-1935. The fort has many tanks containing water throughout the year. Its colonies are ellipsoidal or slightly egg-shaped. They are either asexual or monœcious.

The asexual colonies. They are of varied size. The biggest observed was $2640\mu \times 2704\mu$. These colonies have 6 to 7 daughter colonies each measuring upto $825\mu \times 726\mu$. The number of daughter colonies varies greatly. The number is generally less than 10, but specimens are not wanting where the number is as high as 36 (Plate V, fig. 14) In the daughter colonies some cells are differentiated. These cells are more than 100 in number and hence it is safe to conclude that these are the initials of the reproductive cells, possibly of oogonia. The initials measure about 6.5μ to 9μ . The asexual colonies (Plate V, fig. 13) are also of smaller sizes, even smaller than the daughter colonies noted above. The protoplasts are roundish in outline as seen in surface view. The number of the cells in the coenobium varies between 18000 and 32000.

The size of the vegetative protoplast (Text-fig. 7, B) is from 4μ to 6μ and the distance between them varies from 4μ to 7μ . In old colony especially the distance between the cells of the anterior part is very great. It is observed that at the posterior it is from 5μ to 7μ , while at the anterior it is from 9μ to 18μ .

Professor Iyengar has noted a very important point in this form and that is the presence of thin protoplasmic strands which are only seen under very high magnification and with particular staining. In the observations taken, however, no such strands could be detected inspite of all the care taken.

The sexual colony. It is monœcious and as said above, is differentiated while it is within the mother colony. These colonies (Plate IV, fig. 12) measure from $693\mu \times 594\mu$ to $1486\mu \times 1333\mu$. The number of antheridia is from 5 to 11. They are mainly on the anterior side. Each antheridium measures about 42μ . The number of oogonia varies greatly. It is from 60 to 150 in general but in a few cases it was even more.

The oospores are characterised by their smooth wall which is double. They measure upto 38μ to 40μ (Plate IV, fig. 11).

This form of *Volvox* appears to be protogynous as in many cases along with the ripe oogonia young antheridia were seen associated in the same colony.

VOLVOX PROLIFICUS—IYENGAR

This species of *Volvox* was collected from the tanks of the fort Sinhgad and from a large water reservoir in the Purandar fort. This form was mainly identified because of Professor Iyengar's observations on the antheridia of this species. The plants are either asexual or sexual and the male and female colonies are distinct.

The asexual colonies. They are oval in outline and vary from $561\mu \times 627\mu$ to $1350\mu \times 1450\mu$ (Plate II, fig. 3). The number of its daughter colonies is generally 2 or 3 and in a few cases it may be upto 7. The size of the daughter colony about to escape is $462\mu \times 396\mu$. Occasionally a big daughter colony is found inside the male colony.

The size of the cell protoplast (Text-fig. 7, C) varies from 5μ to 7μ . The distance between two adjoining protoplasts at the posterior is about 4μ while that at the anterior is about 12μ . The protoplasmic strands are visible in fresh material but are not seen in old or preserved specimens.

Female colonies. They are also oval or slightly egg-shaped (Plate II, fig. 3). These colonies measure upto $1089\mu \times 924\mu$. The number of the oogonia is large, as in the specimens observed it was 221 and 282. This number appears to increase with the age of the colony. In some female colonies structures like antheridia were

seen, but as they were not clearly identified nothing could be said about them.

Male colonies. They can be differentiated very early from the development of antheridia. The various stages in the development of the antheridium (Plate III, fig. 5) are simultaneously observed in a colony. The male colony is big and oval or slightly egg-shaped. It has the same size as of the female colony being $1023\mu \times 891\mu$. The antheridial initial was 15μ , the two-celled 17μ and four-celled 21μ while a ripe antheridium measured from 42μ to 45μ . The antheridium is roundish and disc shaped.

Oospores. They are round and distinctly stellate (Plate IV, fig. 10). The spines are conical or slightly blunt and measure upto 9μ . The size of the oospore without spines, is about 30μ .

This form Professor Iyengar (9) has described in detail and recorded from the Madras Presidency and the writer has extended its habitat to the Bombay Presidency.

VOLVOX CARTERI (STEIN)

While the different stages of Volvox from Poona were being collected this alga was found in some small pools. To begin with the material was available in small quantity but later on abundant supplies could be had from the same locality. It was very easy to mark out this alga due to the absence of any protoplasmic strands. The material was obtained from the middle of September to the end of October only. The colonies of this plant are asexual, male and female.

Asexual colonies. They are more or less globose varying from $264\mu \times 231\mu$ to $891\mu \times 792\mu$. The number of daughter colonies is generally from 8 to 12 arranged more or less in pairs or in fours. The daughter colonies invariably show grand daughter initials. The grand daughter initials measure upto 21μ . The daughter colonies measure upto $198\mu \times 231\mu$.

The protoplasts (Text fig. 7, D) are roundish in outline as seen from the surface. The diameter of the cell is 6.7μ to 8μ . The size and the number of cells gradually diminish towards the anterior end and therefore the distance between two adjoining protoplasts is not the same all round. At the posterior end the distance between two protoplasts is 13μ while at the anterior it is as much as 22μ . There are no protoplasmic strands (Text-fig. 7, D). Even after staining protoplasmic strands could not be seen. The number of cells in a colony is between 3200 and 4500.

Sexual colonies. The sexual phase appears after the asexual phase as it was quite evident from observations made from day to day. The sexual colonies are either male or female. They first appear like the asexual colonies but later on they begin to show the development of male or female reproductive organs. In some cases some of the daughter colonies remain vegetative while others develop as male colonies (Plate I, fig. 2). This clearly shows the transformation of vegetative phase to reproductive one.

Male colonies. The size of the matured male colony inside the mother is $238\mu \times 252\mu$. This size diminished later on probably with the changes in the conditions of the habitat as in later observations the size was as small as $126\mu \times 140\mu$. The number of male colonies is nearly the same as the asexual colonies. Only in some abnormal cases the number was as high as 40. The development of the antheridium takes place while still within the mother colony. It is similar to that in other forms of *Volvox*. A single-celled antheridial initial is about 15μ , the two-celled 17μ , four-celled 19μ and the matured antheridium measures about 35μ . The antheridium is a platelet and not globoid. The whole male colony seems to be occupied by antheridia, their number being more than 75 or near about 100 (Plate III, fig. 6).

The female colonies. They are similarly developed. The size of the colonies is much larger measuring $504\mu \times 455\mu$. Later on the size was as small as $245\mu \times 210\mu$. The number of female colonies was generally 8 to 12 but in some abnormal cases it was as large as 60 in one mother colony. Each female colony has 30 to 35 oogonia (Plate I, fig. 1). The oogonia are developed from the original vegetative cells and the size of the ripe oogonial cell is 35μ .

The oospores. Their number is about 35 in each colony. The oospore (Plate IV, fig. 9) varies between 42μ and 45μ . The outer wall is wavy in outline. It can neither be called smooth nor spiny.

This alga was first described by Carter from Bombay in 1859 as *V. globator*. Later on Stein revised it and has named it *V. carteri*. Iyengar has reported it from Mylapore (Madras) (9).

ACKNOWLEDGMENTS

The author takes this opportunity to express his indebtedness to his teacher Professor D. L. Dixit of the Fergusson College, Poona, for his help. He also thanks the authorities of the Bombay University for the grant they have made towards this work.

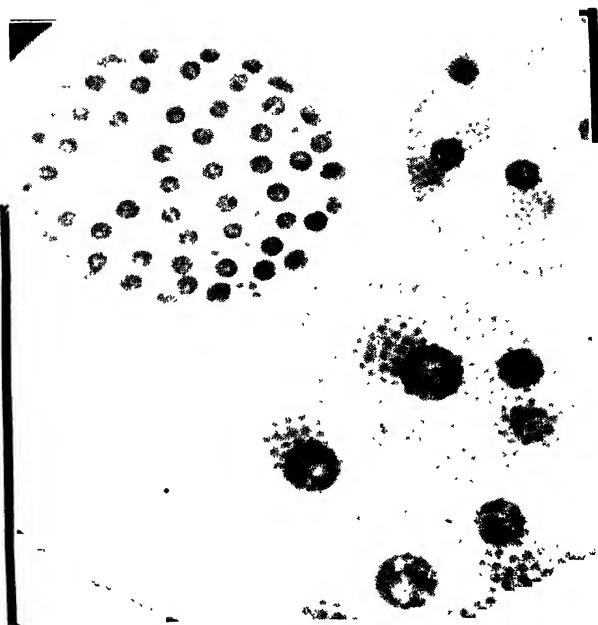


Plate I, fig. 1—Photograph of *Volvox carteri* showing large asexual and small female colonies. x80

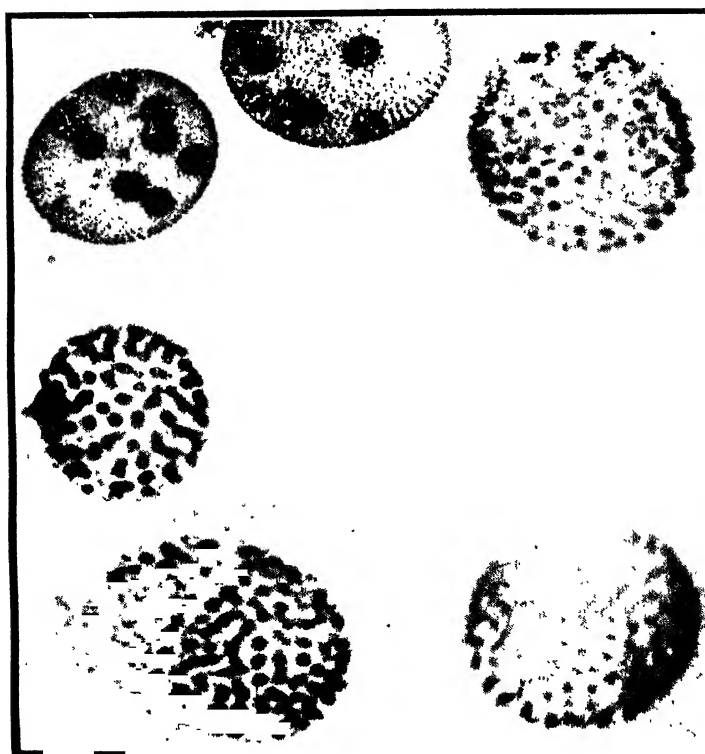
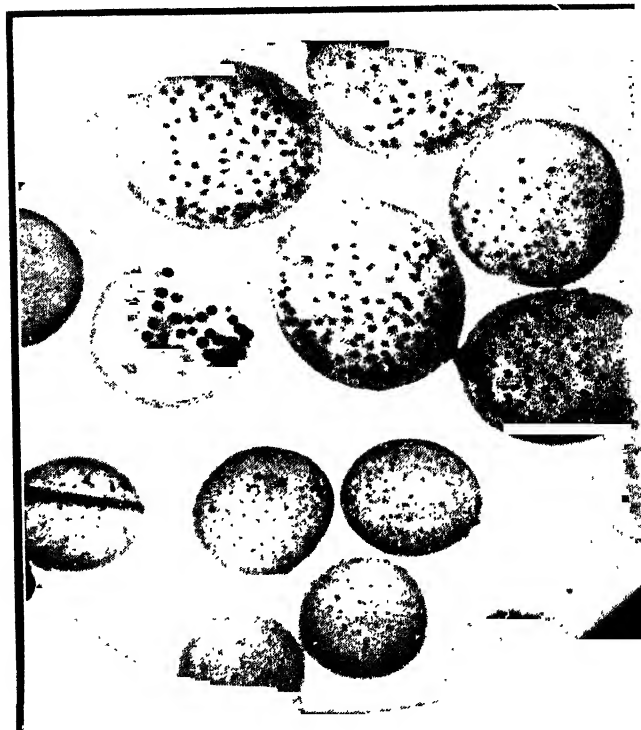




Plate II, fig. 3 -Photograph of *Volvox prolificus* showing asexual and sexual colonies. A male colony with antheridia is seen in the centre, x50



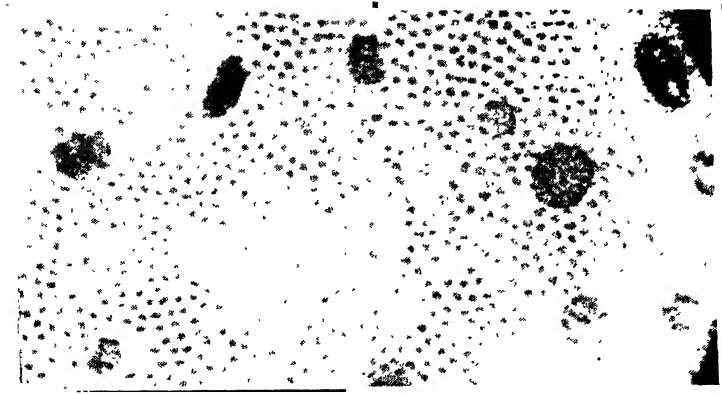


Plate III fig. 5—Photograph of a male colony of *Volvox prolificus* showing different stages of developing antheridia. x250

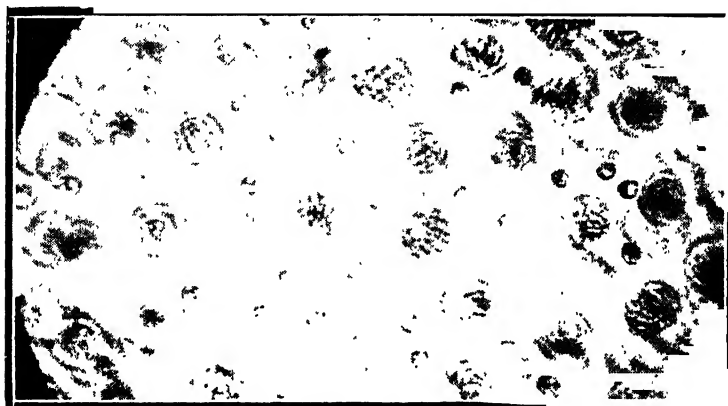


Plate III fig. 6—Photograph showing a male colony of *Volvox carteri* containing many antheridia. x250

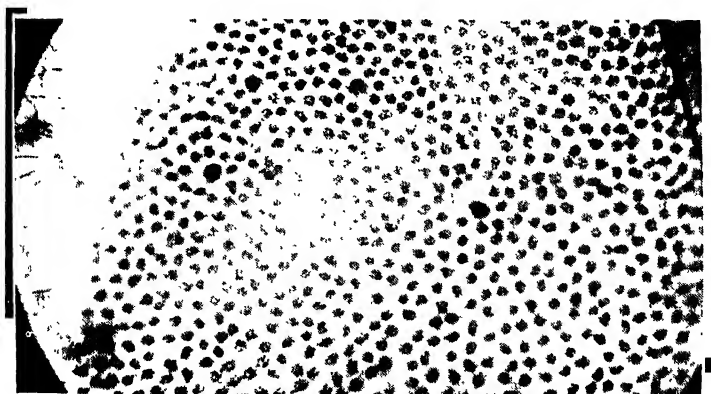


Plate III fig. 7—Photograph showing the vegetative cells in the matrix of *Volvox poonaensis*. x1,000



Plate IV, fig. 8—Photograph of ripe oospore of *Volvox poonaensis*. x1,000



Plate IV, fig. 9—Photograph of ripe oospore of *Volvox carteri*. x1,000



Plate IV, fig. 10—Photograph of ripe oospore of *Volvox prolificus*. x1,000



Plate IV, fig. 11—Photograph of ripe oospore of *Volvox dissipatrix*. x960



Plate IV, fig. 12—Photograph of *Volvox dissipatrix* sexual colony with oogonia and an antheridium. x120



Plate V fig. 13 -Photograph of *Volvox dissipatrix* with sexual and asexual colonies. x16



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A NOTE ON SOME ABNORMALITIES IN PLANTS
COLLECTED IN BOMBAY

(*With 6 Text and 5 Plate figures*)

BY

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AND

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Any deviation from the normal is always regarded with interest. In plants particularly, abnormalities have been of great use as they have shed light on some important problems. For example, the foliar nature of the stamen was recognised when the primordia of stamens were found to be transformed into petals in so-called double flowers. Abnormalities are of great value not only for solving morphological problems, but according to Gœbel we can obtain through the study of malformations a deeper insight into the homology of organs and especially of the reproductive organs in the higher plants.

The abnormalities described in this paper came our way in the course of collecting material for work in our laboratories at the Royal Institute of Science. Some of them are peculiarly interesting and these, to our knowledge, have not been reported on in India before. We have therefore described them without entering into a discussion of their causes.

(1) PROLIFERATION IN THE CAPITULA OF CALENDULA
OFFICINALIS. *N. O. Compositae*

The material (Text-fig. 1, Plate figs. 1, and 2) was collected from two flower beds in the Bhandarwada Reservoir Gardens at Mazagaon in the month of September 1933. The plants were grown from seeds ordered from England. They seemed quite healthy, most of them giving rise to normal inflorescences, with the exception of about ten or twelve plants in each bed which showed proliferation in the capitula, somewhat of the nature of that observed by Sinha¹ in *Tagetes*. As seen from the figures,

1 Sinha B. N. On a Peculiar Abnormality of Capitula in *Tagetes erecta*.
The Jour. of the Ind. Bot. Soc. Oct. 1930,

(Text fig. 1 and Plates 1 and 2) the receptacle of the primary capitulum gave rise to secondary capitula varying from ten to fifteen in number. These secondary capitula arose from the

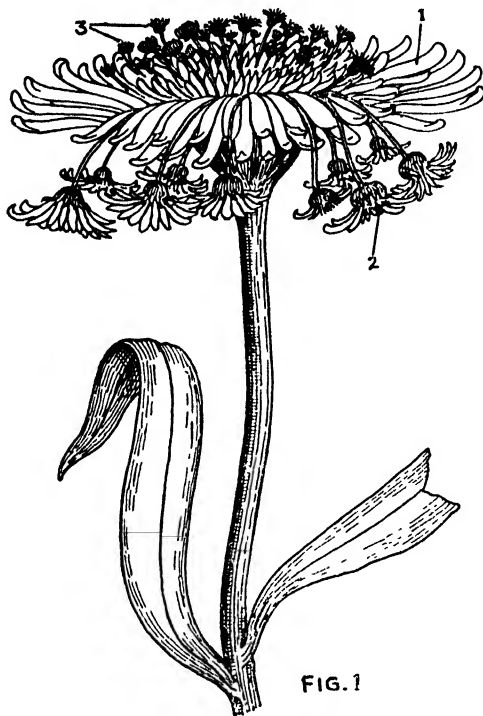


FIG. 1

Text fig. 1—Proliferation of the capitula in *Calendula officinalis*.

- 1...main capitulum. 2...secondary capitula from the axils of involucre bracts.
3.....secondary capitula forming a mass over the main capitulum.

axils of the involucre bracts. Their peduncles varied from 1 inch to 3 inches in length. They appeared first. A little later from all over the primary capitulum, there arose a number of secondary capitula whose peduncles did not exceed $\frac{3}{4}$ inch in length—in fact some of them were only $\frac{1}{4}$ inch in length. These also arose from the axils of bracts which were quite normal in appearance. They formed a closely-topped mass over the disc florets. Though the secondary capitula were carefully examined, no tertiary capitula were found, neither were there any petaloid or pinnatifid bracts as observed by Sinha in *Tagetes*.

Willis¹ has described the same abnormality in *Calendula officinalis* which he calls a 'hen-and-chickens' variety. But he

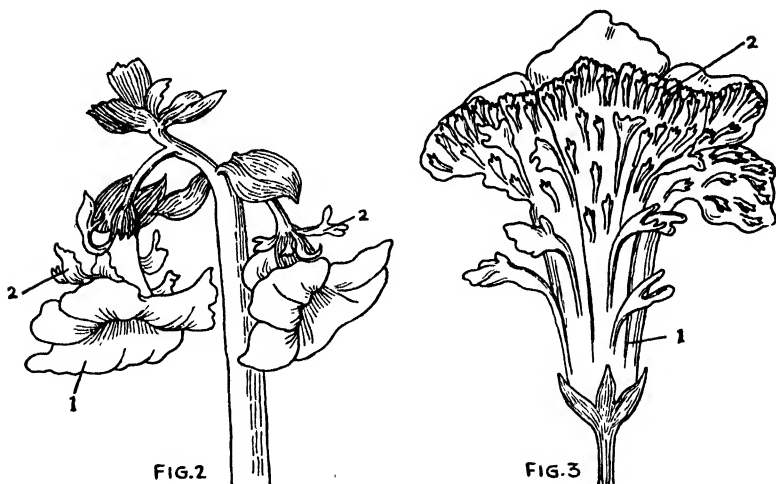
1 Willis J. C. A Manual and Dictionary of the Flowering plants and Ferns. Cambridge Univ. Press 1914.

makes no mention of secondary capitula arising from all over the primary capitulum, but only from the axils of the involucre bracts. Secondly according to Willis, the ray florets are female and the disc florets male, of both primary and secondary capitula. In this case, some of the ray florets were female and the others neuter, but the disc florets in both the primary and secondary capitula were hermaphrodite and quite like the normal disc florets. Nicholson¹ has also described a hen-and-chickens variety of *Calendula officinalis* which he names var. *prolifera* and he has also observed the same variety in the common daisy ; but he too only depicts in his diagram the secondary capitula arising from the axils of the involucre bracts.

(2) SECONDARY FLOWERS ON THE COROLLA OF PETUNIA

VIOLEACEA. N. O. *Solanaceae*

The specimens (Text figs. 2 & 3, Plate 1 fig. 3) were obtained from among a number of plants growing in a basket at the Bhandarwada Reservoir Gardens in February 1934. The plants



Text fig. 2—Rudimentary flowers on the corolla of *Petunia violacea*.
1...corolla. 2...rudimentary flower.

Text fig. 3—Rudimentary flowers on the margin of the corolla of *Petunia violacea* in large numbers.

developed flowers with the normal infundibuliform corolla, 5 stamens and the superior bicarpellary pistil. Some flowers, however, showed a peculiarity with regard to their corollas. From

1 Nicholson George, Illustrated Dictionary of Gardening, London.

the ribs of the corolla at the back, there arose about 8 to 10 small flowers about $1\frac{1}{2}$ cms. in length and $\frac{1}{2}$ and $\frac{3}{4}$ cm. in diameter at the mouth of their corolla tubes. Within these smaller flowers borne on the main corolla, there were 5 rudimentary stamens represented by thin filaments only. There was no trace of a pistil. In one case there were a few secondary flowers borne at the back of the main flower while on the margin of its corolla, there were over 20 to 30 secondary flowers forming a dense cluster. Though in cultivated forms one comes across corollas exhibiting various types of frills, lobes etc., such deviations are rare and no secondary flowers as found in this specimen have been observed.

(3) TERMINAL PHYLLODY AND PROLIFERATION OF THE FLOWERS OF *SESAMUM INDICUM*. *N. O. Pedalinae*

The plant was found in the month of November 1934 growing



FIG. 4

Text fig. 4—Phyllody and Proliferation of the flowers of *Sesamum indicum*.

1...flower turned leaf-like. 2...leaf-like shoot arising in place of the gynaecium.

Normal : K5, C(5), A4, G(2)

Abnormal : K5, C(5), A4, Go.

The calyx of the abnormal flowers consisted of five free sepals, each elliptical in outline, with acute apex and $\frac{1}{2}$ inch in length. The corolla of five petals was gamopetalous and more or less cup-shaped and digitaliform as in the normal flowers; but instead of being of the usual pinkish-white colour they were yellowish-green.

on a rubbish heap on a newly reclaimed plot of land at Colaba. It had its normal height of about 2 feet. In the lower region, it bore flowers, one in the axil of each leaf; but towards the top the branches were rather overcrowded and the flowers that appeared in the axils of the leaves here, showed not only phyllody but proliferation at the same time (Text fig. 4, Plate 1 figs. 4 and 5). These abnormal flowers were also distinguished by the absence of the gynaecium. The floral formula of the normal and abnormal flowers are given below.

The androecium consisted of 4 free stamens while the gynaecium was totally absent. In its place, there arose a leaf-like shoot.

(4) FASCIATION OF THE PEDUNCLES OF GAILLARDIA PULCHELLA.

N. O. Compositae

The material was collected from the Institute Gardens in August 1934. The specimens showed fasciation of the peduncles of the capitula. Two or three peduncles were usually united and at the apex of the united peduncles two or three free capitula were usually borne (Text-fig 4). In a few cases however, the

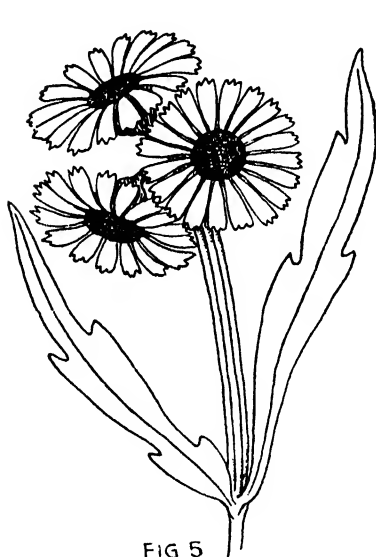


FIG 5

Text fig. 5—*Gaillardia pulchella* showing union of three peduncles but with three free capitula at the end.

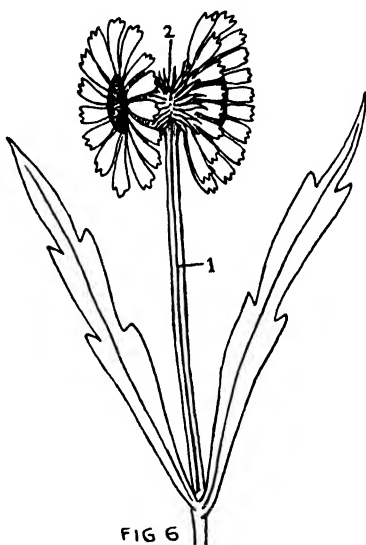


FIG 6

Text fig. 6—Fasciation of the peduncles and receptacles of *Gaillardia pulchella*.
1...fasciated peduncles.
2.. united receptacles.

union of the receptacles of two capitula was also observed, so that it appeared as if the two capitula were joined together back to back. (Text-fig. 5). Both the disc and the ray florets were quite normal.



FIG 1



FIG. 2



FIG. 3



FIG. 4



FIG. 5

Figs. 1 and 2—Photographs showing proliferation of the capitula in *Calendola officinalis*, 1 main capitulum 2 secondary capitula.

Fig. 3—Photograph showing rudimentary flowers on the corolla of *petunia violacea*, 1 rudimentary flower, 2 rudimentary flowers on the margin of the corolla in large numbers.

Fig. 4—Photograph showing proliferation and phyllody in *sesamum indicum*, *N. B.*—It is difficult to distinguish the flowers which became leaf-like in photographs.

Fig. 5—A few flowers of *Sesamum indicum* which have turned green. From their centres arise leaf-like shoots, 1 Flower, 2 Leaf-like shoots

ON THE CHROMOSOME NUMBERS IN SOME CULTIVATED AND WILD CUCURBITS OF GUJARAT

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INTRODUCTION

The family Cucurbitaceae includes a very wide range of forms scattered throughout the whole of India. There are numerous cultivated plants as well as a large number of wild forms and their adequate treatment for purposes of classification forms a serious and difficult problem.

Working on the American Cucurbits, Whitaker ('33) reports that the striking variability of the external morphological characters of a number of genera and species of this family is not apparently correlated with differences in chromosome numbers. Assuming that the study of the chromosome numbers in some common Indian Cucurbits may afford some help in dealing with the phylogeny, distribution and affinities of the different species of this very interesting and economically important family, I have been investigating a number of plants during the past several months and a brief account of the results so far obtained regarding the chromosome numbers in the family is given in table I. A complete and up-to-date list of the number of chromosomes in the Cucurbitaceae is given in table II as reported by McKay ('30, '31), Whitaker ('30, '33), Gaiser ('33) and Tischler ('31).

TABLE I

Species	Chromosome numbers			
Trichosanthes cucumerina, L	11
Trichosanthes Anguina, L...	11
Trichosanthes Palmata, L...	11
Momordica Charantia, L	11
Momordica dioica, Roxb.	14
Luffa acutangula, Roxb.	11
Luffa acutangula var. amara, Roxb....	11
Luffa echinata, Roxb.	11
Benincasa cerifera, Roxb.	12
Coccinin indica, Wight and Arn.	12

TABLE II

Reported Chromosome Numbers in the Cucurbitaceae.

Species	N	2N	Reported by
<i>Benincasa cerifera</i> ...	...	40	J. W. McKay
" " ...	12	...	Whitaker, Sutaria
" hispida ...	...	24	J. W. McKay
<i>Bryonia alba</i> ...	10	...	Von Boenicke, Meurman
" dioica ...	10	...	Strasburger, Meurman, Lindsay
<i>Bryonopsis laciniosa</i> ...	...	24	J. W. McKay
<i>Citrullus vulgaris</i> ...	11	...	J. W. McKay, Kozhukhow
" " var. <i>kleckley</i> ...	11	22	Passmore
" " " <i>Radio</i> ...	11	22	Whitaker
" " " <i>Tom Watson</i> ...	11	22	"
" <i>Colocynthis</i> ...	11	...	"
<i>Coccinia hirtella</i> ...	12	24	McKay
" <i>indica</i> ...	12	...	R. N. Sutaria
<i>Cucumis Anguria</i> ...	...	24	Kozhukhow
" <i>anguria</i> var. <i>West India</i> ...	11	22	Whitaker
Gherkin			
" <i>dipsaceus</i> ...	...	24	Kozhukhow, McKay
" <i>erinaceus</i> (?)...	...	24	"
" <i>flexuosus</i> (?)...	...	24	"
" <i>grossularia</i> ...	...	24	"
" <i>lyratus</i> Zim ...	...	24	"
" <i>melo</i> ...	12	...	J. W. McKay
" " Var. <i>Chinensis</i> ...	...	24	Kozhukhow
" " " <i>flexuosus</i> ...	...	24	"
" " " <i>Lake Champ-</i> <i>lain</i> ...	12	24	Whitaker
" " Var. <i>Golden Beauty</i> ...	12	...	"
" " " <i>Persian</i> ...	12	...	"
" " " <i>microcarpous</i> ...	...	24	Kozhukhow
" " " <i>Rock Ford</i>...	...	24	Passmore
Cantaloupe			
" " " <i>vulgaris</i> ...	...	24	Kozhukhow
agrestis			
" " Var. <i>vulgaris cultus</i> ...	...	24	"
Pang			
" <i>metuliferus</i> ...	12	24	" McKay.
" <i>myriocarpus</i> ..	12	24	" Whitaker.
" <i>odoratissimus</i> (?)	...	24	"
" <i>prophetarum</i> ...	...	24	"
" <i>sativus</i> ...	7	14	" McKay, Heimlich, Passmore
" " var. <i>Everbearing</i> ...	7	...	Whitaker
" " " <i>Henderson</i> ...	7	...	"

Species	N	2N	Reported by
<i>Cucumis sativus</i> var. Short Green	7	14	„
Gherkin			
„ „ „ <i>usantarensis</i>...	...	14	Kozhukhow
„ „ „ White Spine	...	14	Passmore
Cucumber			
<i>Cucurbita digitata</i> ...	...	40	McKay
„ <i>ficifolia</i> ...	...	40	„
„ <i>foetidissima</i> ...	...	40	„
„ <i>maxima</i> (Hubbard	20	40	Castetter
Squash)			
„ „ var Mammoth chili	...	40	Whitaker
„ „ „ W a r t e d	20	...	Passmore
(Hubbard Squash)			
„ „	24	...	Kozhukhow
„ „	...	24	Rau
„ <i>melanosperma</i> ...	20	...	Whitaker
„ <i>moschata</i> var. Large	24	48	Castetter
Cheese ...	...	
„ <i>moschata calhoun</i> ..	24	48	Whitaker
„ „ ...	...	24	Kozhukhow
„ <i>palmata</i> ...	20	40	McKay
„ <i>pepo</i> var. Eng. Vege-	20	...	Passmore
table marrow ...			
„ <i>pepo</i> var. Jessey White	20	...	„
Bush Squash ...			
„ „ White Luxury	20	40	Whitaker
„ „ var. <i>pomiformis</i>	20	...	Kozhukhow
„ „ „ <i>citrullina</i> ...	21	...	„
„ „ „ Orange	20	...	Whitaker
gourd ...			
„ „ var. Orange	20	...	„
gourd Long			
Island Bush			
<i>Cyclanthera explodeus</i> ...	16	...	McKay
„ <i>pedata</i> ...	...	32	„ Whitaker
<i>Echallium elaterium</i> ...	12	24	„ „
<i>Echinocystis (Micrampelis) fabacia</i>	16	32	„
„ „ „ <i>lobata</i>	16	...	Kirkwood
<i>Gymnopetalum leucosticum</i> ...	...	22	McKay
<i>Ibervillea lindeimeri</i> ...	...	22	„
„ sp. ...	...	24	„
<i>Lagenaria vulgaris</i> ...	11	22	„ Whitaker
„ „ ...	17	...	Morinaga & others
<i>Luffa acutangula</i> ...	13	26	McKay, Sutaria
„ „ var. <i>amara</i> ...	13	...	Sutaria
„ <i>aegyptiaca</i> ...	13	...	Asana & Sutaria,
			Morinaga and others.
„ <i>cylindrica</i> ...	11	22	Passmore
„ „ ...	13	26	Whitaker

Species	N	2N	Reported by
<i>Luffa echinata</i> ...	13	...	Sutaria
„ <i>gigantia</i> ...	13	26	McKay
„ <i>marylandica</i> ...	13	26	„
<i>Melothria abyssinica</i> ...	12	...	Whitaker
„ <i>punctata</i> ...	12	24	„ , McKay
<i>Memordica Balsamina</i> ...	11	22	„ , „
„ <i>Charantia</i> ...	11	22	„ , „ Sutaria
„ <i>dioica</i> ...	14	...	Sutaria
<i>Sicyos angulatus</i> ...	12	24	McKay
<i>Trichosanthes anguina</i> ...	11	22	„ , Sutaria
„ <i>cucumerina</i> ...	11	...	Sutaria
„ <i>dioica</i> ...	11	22	M. C. Das
„ <i>Japonica</i> ...	11	...	Y. Sinoto, Sugimoto
„ <i>palmata</i> ...	11	...	Sutaria

MATERIAL AND METHODS

The material used in connection with this investigation consisted of seeds of cultivated varieties obtained from commercial firms. The flower buds of wild plants were collected from the hedges and fields from the vicinity of the Gujarat College, Ahmedabad.

Several fixatives, containing osmic acid, were used, but it was found that by far the best results were obtained by fixing in Karpechenko's solution as given by McKay ('31).

Solution A

Water	65 c. c.
Glacial acetic acid	10 c. c.
Chromic acid	1 gram.

Solution B

Water	35 c. c.
Commercial formalin ...	40 c. c.

Equal quantities of solution A and B are mixed immediately before placing the material in the killing fluid. Young flower buds on removing the perianth completely, were fixed for 24 hours in the above solution, after first having been placed for a few seconds in Carnoy's fluid. As the buds sink very rapidly the exhaust pump was not used.

After fixation the material was generally dehydrated with alcohol, cleared with xylol and embedded in paraffin. Sections were cut 9 micra in thickness and stained in Heidenhain's iron-haematoxylin.

OBSERVATIONS

The chromosomes of the different species of the Cucurbitaceae here investigated do not differ considerably in outline and size; but are similar to one another in appearance. The figures were mostly drawn from the polar views of the equatorial plates of the chromosomes at the heterotypic metaphase, where they are generally well spaced and lie in a single plane. No attempt has been made to describe the details of microsporogenesis in the various species as it has already been done by Asana and Sutaria ('32) in *Luffa aegyptiaca*. The writer simply seeks to record the number of chromosomes found in some of the common Cucurbits of Gujarat.

TRICHOSANTHES

In all the species of the genus *Trichosanthes* studied in this investigation, the haploid chromosome number is 11. The chromosomes of *Trichosanthes cucumerina*, L. (Fig. 1), *T. anguina*, L. (Fig. 2), and *T. palmata*, Roxb. (Fig. 3) are almost ovoid or slightly angular in outline and more or less morphologically similar. These counts confirm the determination of *T. Japonica*, Regel. by Y. Sinota ('29) and for *T. anguina* $2n=22$ by McKay ('31) and Whitaker ('33). Chromosome sizes differ somewhat from one species to another, but since variation in size is also found among the chromosomes in a single cell, no particular inference can be drawn from these observations. All the plants are monœcious. *T. cucumerina* is wild and commonly grows in hedges in the rains, while *T. anguina* and *T. palmata* are cultivated as vegetables. In all the species there is no unequal pair of chromosomes as described by Y. Sinota ('29) in *T. Japonica*, which is a diœcious plant.

MOMORDICA

The haploid number of chromosomes in *Momordica Charantia*, L. (Figs. 4 and 5) is 11. Both Whitaker ('33) and McKay ('31) report 11 and 22 as the haploid number of chromosomes respectively in *M. Charantia*. The individual chromosomes are more or less angular in shape and show a slight variation in size.

The haploid number of chromosomes in *M. dioica* is 14. Fig 6 represents the polar view of the heterotypic metaphase of the pollen-mother-cell, where fourteen rounded gemini of slightly differing sizes can be distinctly counted. The plant is diœcious. It is often cultivated as one of the vegetables in Gujarat, but is also found growing wild in hedges from its perennial tuberous roots during rains.

It needs to be emphasised that the number of the haploid chromosomes in the species differs from those of *M. Charantia* and

M. Balsamina, where they are only 11 as reported by McKay ('31) and Whitaker ('33). How this increase in the chromosome number has taken place is not known. It might be that this is a result of the fragmentation of some members of this chromosome complex as has been suggested for the *Salicaceae* by Blackburn and Harison ('24). Fig. 7 represents the polar view of the homœotypic metaphase, where there are 14 chromosomes of different sizes. Late anaphases of the first meiotic division which are most suitable for determining the number of the chromosomes, seem to be of short duration, and these stages are scarcely found in this investigation.

It is for the first time that the number of the chromosomes of this species has been reported and thus the genus *Memordica* affords yet another instance besides *Cucumis* and *Cucurbita* where the number of chromosomes differs in different species of the same genus.

Again it is a noteworthy feature that 14 as the haploid number of chromosomes has not yet been recorded in any plant belonging to the family *Cucurbitaceae*.

LUFFA

The genus *Luffa* is known as having 13 haploid and 26 diploid chromosomes (McKay '31, Whitaker '30 and '33, Asana and Sutaria '32, Morinaga and others '29). Working with one cultivated variety of *Luffa acutangula*, Roxb. (Fig. 8) and two wild bitter forms of *Luffa acutangula* var. *amara*, Roxb. (Fig. 9) and *Luffa echinata*, Roxb. (Fig. 10) the writer also finds the haploid chromosome number in these plants to be 13. A detailed account of the microsporogenesis in *Luffa aegyptiaca*, Mill has already been given by Asana and Sutaria ('32) and the chromosomes of the three above mentioned species of plants are also more or less angular, and both at meta and anaphase stages they do not clump together but stand well apart.

When one refers to the classification of this genus in the Hooker's-Flora of British India, one finds that there is much confusion regarding the identification of the various species. The writer agrees with McKay ('31) in saying that further work should be done in improving the nomenclature of this genus and in eliminating certain names or recognizing them as varities.

BENINCASA

The haploid number of chromosomes in *Benincasa cerifera*, Savi. is 12 (Figs. 11 and 12). It agrees with the observation of Whitaker ('33), while McKay ('31) reports $2n=40$ as the chromosome number of the same species, and 12 for *B. hispida*. It is

probable that the species *B. hispida* of McKay ('31) is really *B. cerefera* as frequently one and the same plant has been known by these two specific names. In that case *B. cerifera* of McKay ('31), containing $2n=40$ may be an entirely different species.

This plant is commonly known as the White Pumpkin or White Gourd-Melon and is largely cultivated in Gujarat for making a native sweet-meat in the cold season. The individual chromosomes are mostly angular and are the largest I have seen in the family Cucurbitaceae.

COCCINIA

The haploid number of chromosomes in *Coccinia indica*, Wight and Arn. is 12, which agrees with $2n=24$ chromosomes in *C. hirtella* as recorded by McKay ('31). The chromosomes (Figs. 13 and 14) are mostly ovoid and of fairly good size. The plant is extensively cultivated as a vegetable in Gujarat, though it also grows wild as a perennial bitter variety in the hedges throughout the year.

SUMMARY

1. The chromosome numbers of 10 Indian species of Cucurbitaceae have been determined from the pollen-mother-cell material,
2. The haploid chromosome number in *Momordica Charantia* is 11, but it is 14 in *M. dioica*.
3. The range of the haploid chromosome numbers hitherto reported for the whole family by various investigators is 7, 10, 11, 12, 16, 20, 24. To these numbers 14 is added as a new haploid number as seen in *M. dioica*.
4. A revision of the classification of the genus *Luffa* is suggested.
5. The haploid number of chromosome in *Benincasa cerifera* is 12 and not 20 as given by McKay.
6. Table II summarizes the reported chromosome numbers in the family Cucurbitaceae.

ACKNOWLEDGMENT

The work described in this paper has been facilitated by a grant received from the University of Bombay for which the writer wishes to express his sincere appreciation. Thanks are also due to Professor J. J. Asana for kindly advice and criticism.

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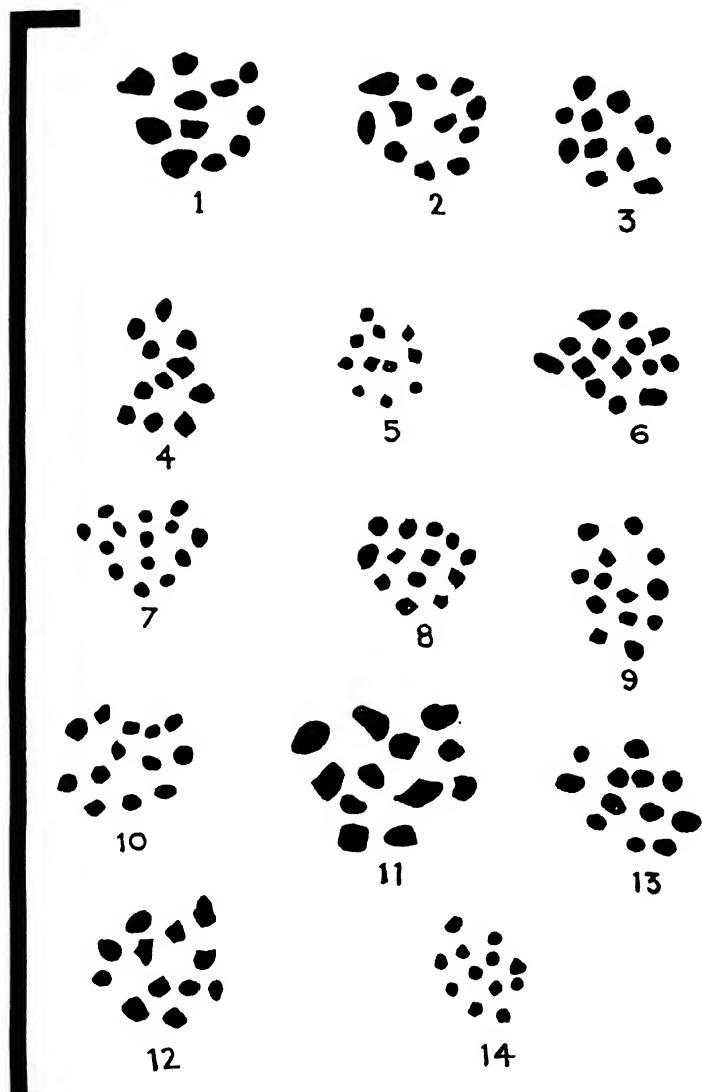
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Drawings were made with the aid of the Abbe Camera Lucida at table level. All figures were drawn under a 2 mm. immersion Zeiss apochromatic lens (N. A. 1.40) with Zeiss compensating ocular 20X. Figures reproduced without reduction.

Fig. 1 Heterotypic metaphase with 11 haploid chromosomes of *Tricosanthes cucumerina*.

Fig. 2 Heterotypic metaphase with 11 haploid chromosomes of *Tricosanthes anguina*.

Fig. 3 Heterotypic metaphase with 11 haploid chromosomes of *Tricosanthes palmata*.

Figs. 4 and 5 Heterotypic metaphase and anaphase with 11 haploid chromosomes of *Momordica charantia*.

Figs. 6 and 7 Heterotypic and homœtypic metaphase with 14 haploid chromosomes of *Momordica dioica*.

Fig. 8 Heterotypic metaphase with 13 haploid chromosomes of *Luffa acutangula*.

Fig. 9 Heterotypic metaphase with 13 haploid chromosomes of *Luffa acutangula* var. *amara*.

Fig. 10 Heterotypic metaphase with 13 haploid chromosomes of *Luffa echinata*.

Figs. 11 and 12 Heterotypic metaphase and anaphase with 12 haploid chromosomes of *Benincasa cerifera*.

Figs. 13 and 14 Heterotypic metaphase and anaphase with 12 haploid chromosomes of

THE MORPHOLOGY OF *SPHAERODEMA* *RUSTICUM* FABR.

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(With 19 Text-figures and 3 Plates)

CONTENTS

	PAGE
I. INTRODUCTION	29
II. HABITS AND LIFE-HISTORY	30
III. THE HEAD	32
IV. THE THORAX	38
V. THE ABDOMEN	46
VI. THE DIGESTIVE SYSTEM	52
VII. THE CIRCULATORY SYSTEM	56
VIII. THE REPRODUCTIVE SYSTEM	57
IX. THE NERVOUS SYSTEM	60
X. SUMMARY	63
XI. LITERATURE	64
XII. EXPLANATION OF THE PLATES AND LETTERINGS	66

I. INTRODUCTION

Observations on the water-bug *Sphaerodema rusticum* of Bombay ponds kept in a small laboratory aquarium led to a study of its respiratory system which was found to possess a number of interesting adaptations for aquatic life. The results of this study are given in a separate paper (29). It was found during the course of the investigation that except for a single paper on the life-history of this insect by Hoffmann (12) there was absolutely no work done on it. A detailed morphological study was therefore undertaken. A part of this study, on the wing co-adaptations, has already been published (28).

TECHNIQUE

For making chitin preparations, parts of the insect, such as the genitalia etc., were kept in a 10 per cent. solution of KOH for over twenty-four hours, washed, stained in Picro-Indigo-Carmine, dehydrated, cleared in Clove Oil, and mounted in Balsam. Other

stains were also used but Picro-Indigo-Carmine was found to be the most satisfactory. This stains the specimens beautiful blue and green, and gives them a stereoscopic appearance. For general histological study materials were fixed in either Carl's Aceto-Formol or Bonin's Fluid. The former gave better results. Sections were cut 10 microns thick and generally stained in Ehrlich's Haematoxylin, which gave complete satisfaction. Other stains, such as Delafield's Haematoxylin, Mallory's Triple, Borax Carmine, were also occasionally used.

II. HABITS AND LIFE-HISTORY

Sphaerodema rusticum Pl. I, Fig. 1 is found to inhabit shallow regions of fresh or slightly brackish water ponds which abound in vegetation. There are many such ponds in the suburbs of Bombay, and specimens were therefore available in large numbers. These ponds possess a vegetation of water-hyacinths, lemma, and other water weeds. *Sphaerodema* is usually found clinging to the submerged parts of the water plants or to the mud at the bottom of the pond. To collect specimens, the mud from the bottom has to be dredged out and carefully searched. It is somewhat difficult to spot them in the mud as they feign death.

The insect population of the pond from which specimens of *Sphaerodema* were collected for this study, consists of two species of *Laccotrephes*—*L. elongatus* and *L. grisea*, species of *Ranatra*, *Plea*, *Notonecta*, *Microvelia*, and of aquatic beetles *Hydrophilus* and *Dytiscus*. Besides these, dragon-fly larvae and pupae are also found. *Belostoma indica* is also suspected to live in this pond as a specimen was collected from the neighbourhood.

The different carnivorous species of fresh water fish usually found in these ponds, the water-scorpion *Laccotrephes elongatus*, and the larger beetles are to be looked upon as the natural enemies of *Sphaerodema*, since in the laboratory aquarium these predators were found to readily feed upon it. *Sphaerodema* also shows cannibalism to some extent. The ectoparasitic pupa of *Hydrachna* (Arachnida) has been found to infest *Sphaerodema*.

In the laboratory, *Sphaerodema* was observed to feed readily upon various small animals, such as—larvae and pupae of mosquitoes and dragon flies, maggots of flies, small aquatic snails, small tadpoles of frog, small fresh water fish, etc. It could also be fed on pieces of liver and flesh. The bug catches hold of the prey with its raptorial fore-legs, balances itself with the others on some support in the water, and pierces the victim with its stylets. The victim

struggles for a moment, and then lies still and in a few moments it is sucked dry.

As in some species of *Belostoma* the males of *Sphaerodema rusticum* carry the egg rafts on their backs until they are hatched. That the eggs require to be aerated on the surface of the water has been found by the fact that eggs accidentally detached from the backs of the insects and left submerged in the water fail to hatch. Detached egg rafts if placed half submerged in a flat dish hatch out in due course. The eggs placed out of water do not hatch but dry up. The method of carrying the eggs on the back of the insect is therefore a suitable means of keeping them moist in water at the same time aerating them when the insect goes to the surface to breathe.

Egg laying takes place at night and therefore it was not possible to observe it. At times a few newly laid eggs were found on the back of the male one morning, and the next morning more eggs were found added to them. That shows that sometimes it takes more than a day to complete a raft. Hoffmann (12) also has noted this fact. He states: "The eggs in a given batch are not always laid during a single deposition period, for sometimes a few eggs have been observed early in the evening and by morning many more would be present. This is also shown by the fact that hatching of a given batch often extends over two days." Hatching takes place on the ninth day after the eggs are laid. The young nymphs which emerge are pale yellow and transparent but in a few hours they become brown in colour. Mortality is very great among the young nymphs, and only a small proportion survives. Eggs are laid throughout the year, but prolific breeding takes place during and immediately after the first shower of the monsoon (July to October) when a large number of nymphs of different stages could be collected. The nymph undergoes five moults before it becomes adult. According to Hoffmann the average time taken between each instar is 7.2, 5, 5.2, 7.7, and 13.5 days respectively. The measurements of the nymphs of different stages are approximately as follows :

Instar	I	II	III	IV	V
Size (l x b)	4 × 2 mm.	5.5 × 3.5 mm.	7.5 × 4.5 mm.	10 × 5.5 mm.	13 × 8 mm.

(These are slightly larger than those given by Hoffmann.)

The adult varies in size from 15 × 8½ mm. to 19 × 11 mm. In moulting the nymphal skin splits along the mid-dorsal groove

which extends from the head to the second abdominal segment. In the head this groove bifurcates into the epicranial sutures and the cuticle of the head splits open accordingly in moulting. The newly moulted specimens are all pale yellow in colour and very soft and somewhat transparent, but a short exposure makes them dark brown as the chitin hardens and darkens.

It has been said above that *Sphacrodema* feigns death when fished out of the water. This is characteristic also of other allied insects. In feigning death the insect extends the front legs forward close to the head, and the other two pairs straight backwards and close together, and then becomes rigid. The insect remains stiff in this position for a time, but resumes activity if placed back in water. When dead, however, *Sphacrodema* does not show this posture, but has all the legs invariably stretched outwards.

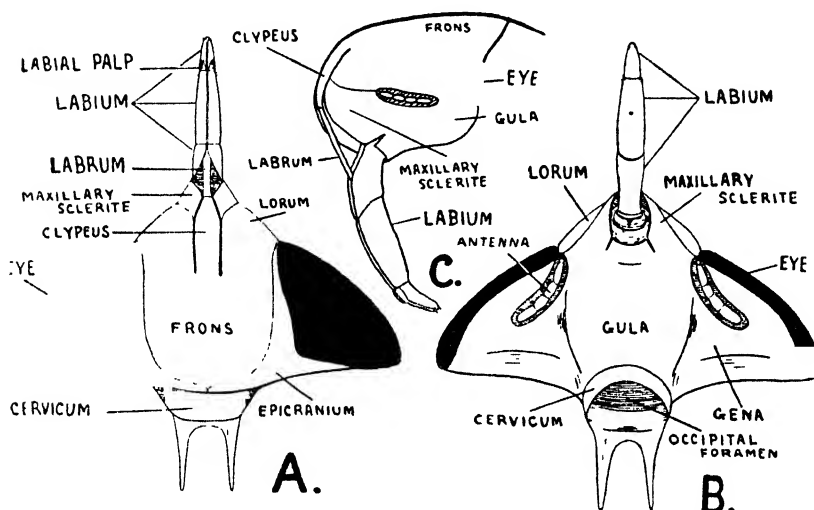
Laccotrophes and *Ranatra* behave in a similar manner, and Hamilton (11) has noted this in *Nepa cinerea*. A monograph on the subject was published by Severin and Severin in 1911 (32) from their study of this instinct in *Belostoma* and *Nepa*. Riley (30) has given a detailed account of this instinct in the water strider *Gerris*. Another noteworthy feature exhibited by *Sphaerodema*, also discussed by Riley for *Gerris*, is that of clinging to one another. Thus supported, the insects float in the water in large groups.

Sphaerodema rusticum shows two forms of adults—the normal winged and the degenerate winged. The normal winged specimens were collected in greater numbers from October 1932 to January 1933, while during the rest of that year the degenerate winged form predominated in all the collections. The next year only in one single collection made in October 1933 the full winged form appeared again in great numbers. The significance of this occasional predominance of the full winged form is not known.

III. THE HEAD

The head (Text Fig. 1.) is more or less triangular in shape, and dorsoventrally flattened. The two large triangular compound eyes are situated dorso-laterally on the head, their outer margins curving a little down to the ventral side. The anterior portions of the head curves down slightly and is prolonged into the rostrum. The small antennae are concealed in foveae on the ventral side of the head.

Dorsally the head is differentiated into its component sclerites by some indistinct sutures. Much difference of opinion exists as regards the homologies of the head sclerites in the Rhynchota as the sclerites are more or less completely fused and their sutures obliterated and it is difficult to identify the various parts with any



Text-Fig. 1—The Head. ($\times 11$) A, dorsal; B, ventral; C, lateral.

definiteness. Hamilton (11) in her paper on *Nepa* discusses at length the opinions of different investigators on this point and it is therefore not necessary to go into the details of the controversy again here. The sclerites have been named here according to the more generally accepted view on this type of insect.

THE EPICRANIUM. At the base of the head is a wide Y-shaped epicranial suture which divides the epicranium from the frons. The stem of the Y is very short and forms the median suture which divides the epicranium into right and left halves. The two arms of the Y, the lateral sutures, diverge towards the eyes and curve forwards.

THE FRONS. In front of the lateral epicranial sutures lies the frons which is a sclerite very difficult to homologue in hemipterous insects. It is a large sclerite not clearly separated from the other anterior sclerites. It was previously described as "clypeus" (Muir and Kershaw, 20) but later Muir (19) recognized it as the frons, and this view has been generally accepted now.

THE CLYPEUS. Two prominent parallel longitudinal slits with membranous connectives divide the anterior part of the head in

front of the frons into three longitudinal regions. The narrow median sclerite is the clypeus which is produced anteriorly to meet the labrum. There is no suture dividing the clypeus from the frons.

THE LORA AND THE MAXILLARY SCLERITES. The two lateral sclerites formed by the above mentioned parallel longitudinal slits are each divided by a curved suture running from each parallel slit to the anterior margin of the eye. The posterior of these sclerites are the lora on the sides of the clypeus. In *Nepa* frontal sutures divide these sclerites from the frons but in *Sphaerodema* these sutures are absent. The anterior lateral sclerites are the maxillary sclerites which curve downwards and meet the floor of the head. Between these projects the rostrum.

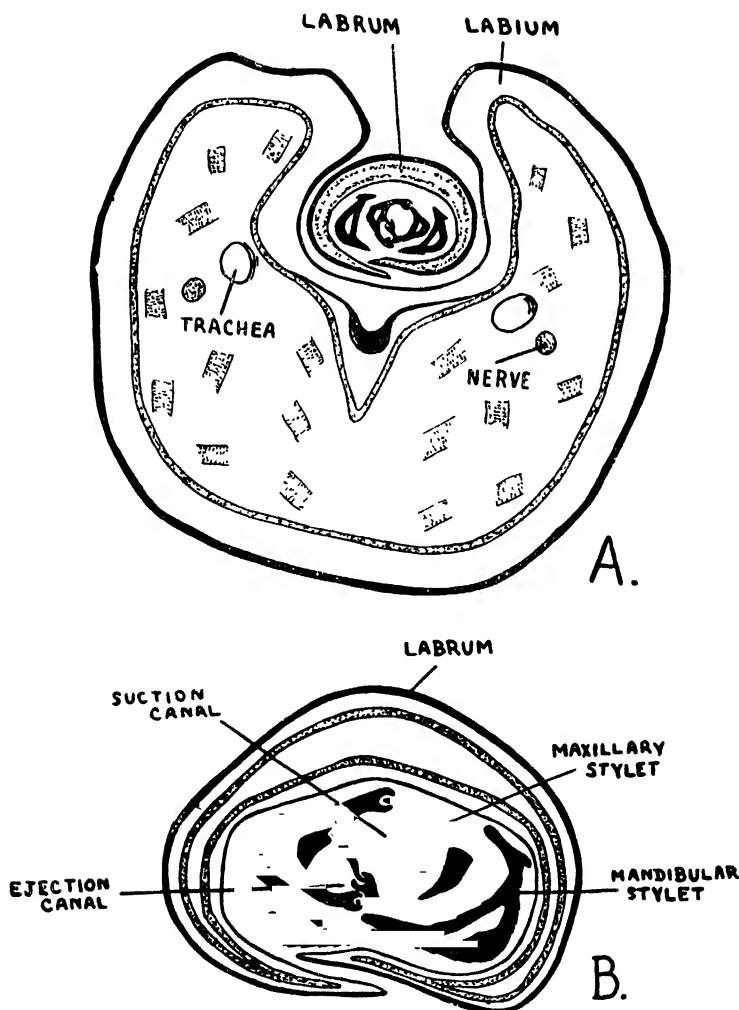
THE GULA AND THE GENA. Behind the ventral portions of the maxillary sclerites is a large sclerite, the gula. Its anterior narrow margin forms the floor of the opening through which the rostrum is projected. The sides of this opening are formed by the maxillary sclerites as mentioned above, and the roof by the labrum. The gula is broad and bulges out posteriorly. No distinct sutures separate it from the maxillary sclerites. Between the gula and the ventral, anterior margin of the eye on each side is a narrow sclerite the gena.

THE CERVICUM. Attached behind to the head is a short ringed sclerite of the neck, the posterior convex margin of which fits into the anterior median concave margin of the prothorax. From the dorsal side of the cervical sclerite project two thin apodemes inside the prothorax and to these the maxillary muscles are attached.

THE ANTENNAE. The antennae are very small and inconspicuous. They are 4-jointed. The second and third segments are prolonged laterally into outgrowths giving the antennae a branched appearance (Pl. II. Fig. 2). Except the basal segment the rest of the segments including the outgrowths bear sensory setae. The antennae are inserted on the ventral side of the head on the gena and remain in side-pockets, the foveae, below the eyes (Text Fig. 1 B). They are shorter than the head and point backwards when at rest. In this state the lateral outgrowths of the middle segments are completely hidden, only the main stems of the antennae being visible. The antennae of both the sexes are similar.

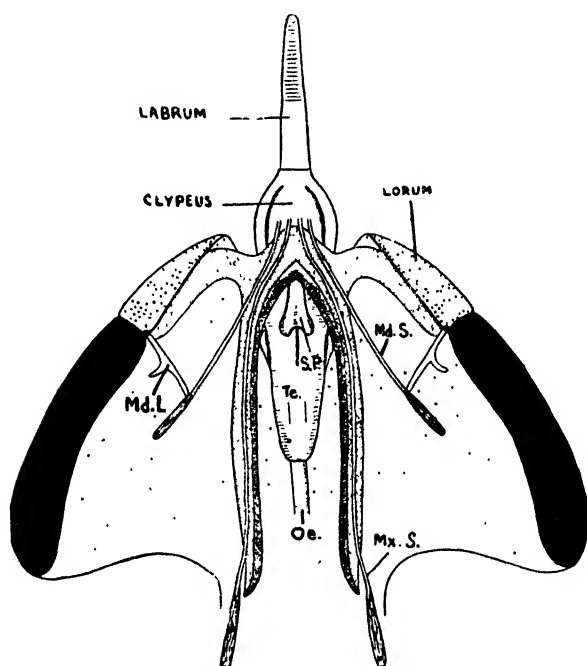
THE MOUTHPARTS. The rostrum (Text Fig. 1) is situated as usual on the ventral anterior end of the head and points backwards. The labrum can be seen leading into the dorsal groove of the labium, the basal half only being visible. For nearly three-fourths of its length from the apex it is faintly annulated. The labium is a

little longer than the labrum and considerably thicker. It is 3-jointed. The proximal joint is narrow at the base and broadens anteriorly. About the middle of its length the sides curve upwards to form the groove into which the labrum and the stylets enter. This groove is continued to the tip of the labium. The middle segment is the longest and bears at its distal end a pair of small pincer-like processes which project over the last segment on the dorsal side. These are regarded as the modified labial palps. The apical segment is the shortest and is movable. Both this segment and the labial palps bear fine sensory hairs at their tips.



Text Fig. 2—T. S. of mouth parts. A, entire rostrum $\times 200$;
B, labrum and stylets $\times 470$.

The maxillary and mandibular stylets are built on the same plan as in other aquaite bugs. They are hidden in the labial groove and the insect is seen to thrust out the maxillae occasionally at the tip of the rostrum, in the manner of a snake shooting out its tongue. The mandibular stylets are shorter than the maxillary pair, the basal attachment of the latter being far behind that of the former (Text. Figs. 3 and 4), but at the apex of the rostrum all the stylets meet in a point. Penetration is first accomplished by the mandibles which protrude out of the rostrum a little and take a grip of the tissue by means of the backwardly projecting teeth at their tips. The maxillae then follow and probe deeper into the prey than

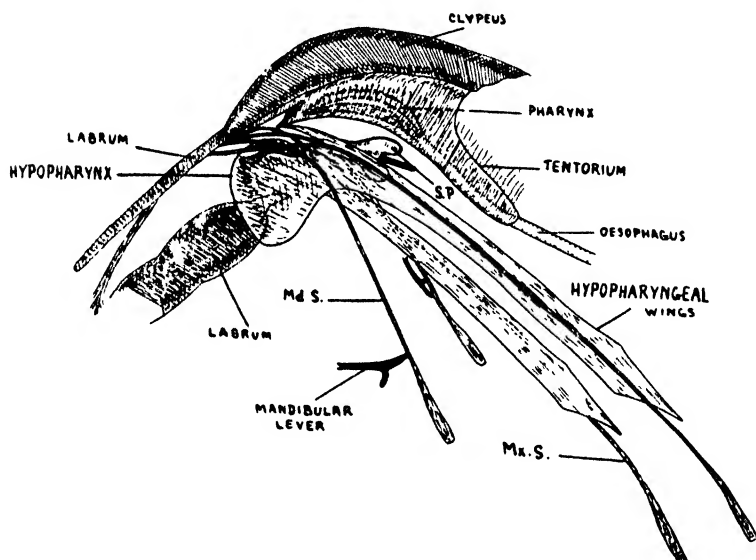


Text Fig. 3—Internal chitinous structure of the Head.
(Ventral view after removing the ventral sclerites)

the mandibles. The maxillary muscles are attached to a pair of apodemes projecting from the hind end of the head inside the prothorax. The mandibular muscle is attached to a small lever placed below the posterior end of the genal suture. The Mandibular stylets bear on the outer margins of their tips six or seven sharp backwardly pointed teeth which as mentioned above help to take a firm hold of the prey. The inner sides of these stylets are grooved and when apposed form a tube into which the

maxillary stylets lie. The maxillary stylets bear their apices a number of fine denticles. The two maxillary stylets are interlocked and move as one. Their inner sides bear double grooves forming two channels, the dorsal for suction and the ventral for saliva injection. When the insect is observed feeding, the movement of the liquid in the suction canal can be easily made out. The ejection cannal does not lie exactly below the suction canal but is placed slightly to the right as can be seen from transverse section (Text Fig. 2 A and B). This is because the lower groove of the right stylet is deeper than that of the left.

THE INTERNAL CHITINOUS STRUCTURE OF THE HEAD. Arising from the sides of the clypeus and projecting down into the head, is a boat-shaped chitinous structure which supports the pharynx (Text. Figs. 3 & 4. Tc.). Muir (19) in *Cicada* and Hamilton



Text Fig. 4—Internal chitinous structure of the Head dissected out.
(Lateral view).

(11) in *Nepa* regarded this as the fused anterior arms of the tentorium. The oesophagus which enters the head through the small opening between the brain and the sub-oesophageal ganglion ends in a chitinous structure, the pharynx, which runs dorsal to the tentorium. The pharynx is W-shaped in transverse section (Pl. II Fig. 14) the median ridge of which bears a row of fine long hair. The pharyngeal muscles are attached to the clypeus above and the

pharynx acts as a suction pump. The pharynx and the oesophagus can be easily separated from the fused arms of the tentorium in *Sphaerodema* as was noted by Muir (19) in *Cicada*. Hamilton (11) states that in *Nepa* the floor of the pharynx "appears to be connected with the fused anterior arms of the tentorium".

The base of the labium is connected with a semi-chitinous rounded capsule which is produced posteriorly into two strap-shaped arms upto the neck region. The dorsal wall of this capsule is notched and the stylets pass over this into the rostrum. This is regarded by Hamilton as the hypopharynx and the two arms as "hypopharyngeal wings", differing from Awati (1) who regarded the hypopharynx as the body of the tentorium and the two arms as the posterior arms of the tentorium. Laterally the hypopharynx is connected to the maxillary plates. The "hypopharyngeal wings" are grooved on the outer sides and the maxillary stylets run along these (Figs. 3 and 4). These arms therefore serve as guides to the maxillary stylets.

Below the tentorium lies the salivary pump (Text. Figs. 3 and 4) which is prolonged anteriorly into the ejection canal of the maxillae.

IV. THE THORAX

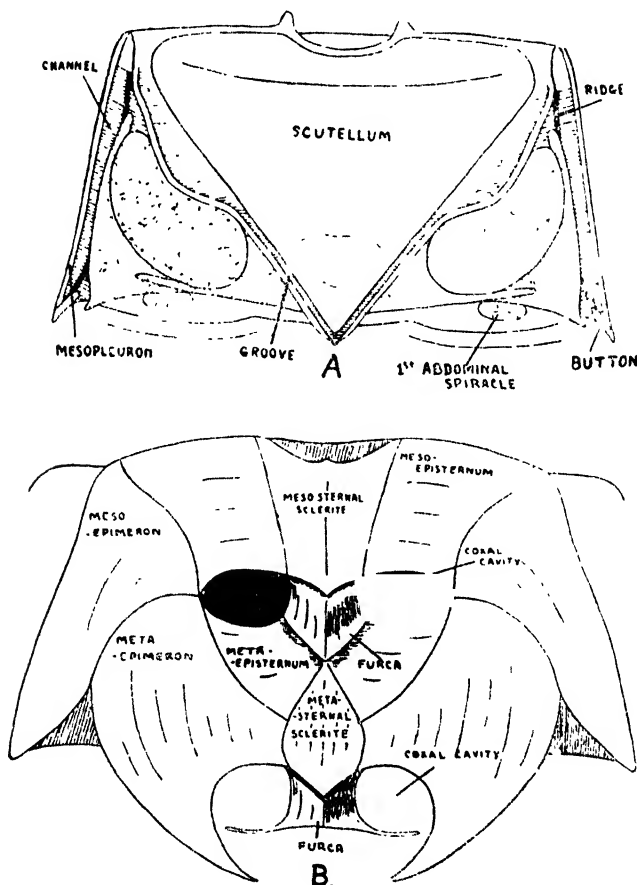
In the entire animal the prothorax and the scutellum alone can be seen on the dorsal side, but when the wings are removed the sides of the metathorax are exposed to view, the middle portion of the latter being hidden under the scutellum. The head and the thorax measure about half the total length of the insect.

THE PROTHORAX. The prothorax (Pl. I. Fig. 1.) when taken with the triangular head forms another larger triangle. The anterior margin of the pronotum is slightly concave in the middle region and into this fits the cervical sclerite. The posterior margin is unbroken and is fringed with short fine hair. A prominent suture runs along the four sides of the pronotum leaving a narrow border on the anterior side and a broad border on the other three sides. A median longitudinal suture runs from the anterior to the posterior suture. The lateral borders of the pronotum are paler in colour than the rest of the surface, and match with the lighter coloured embolia of the hemelytra which follow them. The whole of the posterior border marked off by the suture overlaps the anterior part of the mesonotum which is smoothly curved down to facilitate the movement of the prothorax on it. The hair on the posterior margin prevents water from entering the prothorax.

In the nymphs the marginal suture of the pronotum is not so prominent and leaves only a narrow border all round. The median longitudinal suture seems to be in continuation with the median epicranial suture anteriorly, and is also continued backwards into the meso- and meta-nota and the much reduced first two abdominal segments. In moulting the nymphal skin splits along this longitudinal suture from the head to the second abdominal segment.

The prosternum in both the nymph (Text Fig. 9) and the adult, is smaller than the pronotum and is divided into a median sternal sclerite with a median longitudinal ridge and two triangular pleurites. The coxal cavities are placed on the outer margin of the anterior region of the prosternal sclerite.

THE MESOTHORAX. The mesonotum (Text Fig. 5A) consists only of the scutellum which overlaps the metanotum. The two



Text Fig. 5—Meso- and Meta-thorax. ($\times 11$) A, meso- and meta-nota;
B, meso- and meta-sterna.

lateral margins of the scutellum are deeply grooved and into these the inner margins of the hemelytra fit.

The mesosternum (Text Fig. 5B) is large and bears near its posterior margin the coxal cavities with the furca placed between them. The pleura are distinctly divided into the episterna and the epimera, the latter extending backwards upto the abdomen. The outer margins of the epimera curve over to the dorsal side a little, thus enclosing a channel on either side of the metathorax (Text Fig. 5A). The spiracles of the metathorax open into these channels. A longitudinal ridge divides each channel into two. The posterior end of this ridge bears a button which fits into a corresponding socket on the hemelytron, and thus fastens the hemelytron to the side of the body.

In the nymphs the mesonotum is distinct: the posterior margin of it is somewhat sinuate, and forms three backward projections. The sinuation is very slight in the early stages of nymphs but becomes deeper in the later stages, and from the two lateral projections the wing pads grow. The nymphal epimera (Text Fig. 13) are flap-like and free distally, and hold a small quantity of air around the metathoracic spiracles which they cover.

THE METATHORAX. The metathorax is firmly articulated with the mesothorax. The middle portion of the metanotum (Text Fig. 5A) is covered over by the scutellum.

The metasternum (Text Fig. 5B) is situated between the backwardly projecting epimera of the preceding segment and projects over the first two abdominal sterna. The metasternal sclerite is small and shield-shaped; the pleura are divided into small episterna and large convex epimera. The coxal cavities are placed on the posterior margin.

In the nymphs the metanotum is distinct during the earlier stages but is gradually more and more pushed under the mesonotum as the nymph advances, till in the fifth instar only a bit of it is visible. The meta-epimera bear semicircular out-growths (Text Fig. 9) which extend over the abdominal sterna and serve to hold a quantity of air around the abdominal spiracles.

THE WINGS. We have already described in a separate paper (28) the dimorphism and the various locking arrangements of the wings of *Sphaerodema rusticum*.

The Hemelytra.—In the normal winged form the hemelytron (Pl. I. Fig. 1) bears a well developed membrane which is scantily veined. The venation is not uniform but shows individual variation. This membrane is entirely missing in the degenerate

winged form. The basal coriaceous portion of the hemelytron has very indistinct venation. A well marked embolium is present which is lighter in colour than the rest of the coriaceous portion.

The Membrane Wings.—The second pair of wings in the normal form Pl. I. Fig. 1 is of the usual type being thin, membranous and triangular in shape. It is a little shorter than the hemelytron but very much broader, and is therefore folded along the anal region. The costal margin is slightly turned upwards in some part and is in that part dented.

The homology of the veins in this group of insects is a matter of some controversy. As commonly recognized the costal vein is merged with the subcostal and is not distinguished in the imaginal wing. The subcostal, radial and median veins unite at their apices to form two longitudinal cells. They give out a number of transverse branches but these are not so well developed and the wing remains delicate. The cubital is unbranched and is convex distally. In the anal region two short anal veins are present.

THE LEGS. The three pairs of legs are somewhat dissimilar being modified to perform different functions, though on the bottom of the pond all the three pairs are used for ambulatory purposes.

The Prothoracic Legs.—The fore-legs are raptorial, being short and stout and perfectly modified for the function of seizing and holding the prey. They are also used for grasping water plants for support. They start very close together from the anterior region of the prothorax and when the bug is at rest on the surface of the water they are folded so close to the restrium that they are not visible from the dorsal side. The coxa is long and bears a shallow depression on the upper side for the femur to rest when folded. The trochanter is small and articulated to the base of the femur and movable along with it on the coxa. The femur is very broad and flat and a little longer than the coxa. It bears a few stout spines on the upper surface. The lower edge is grooved and into this the tibia and tarsus fit, like the blade of a pen-knife fitting into the handle, when folded. Along the groove are short fine hair. The tibia is narrow and a little shorter than the femur, and together with the tarsus can be completely folded on the femur. All along its lower edge are present short fine hair. The tarsus is very short and single-jointed both in the nymph and the adult, and bears a pair of small claws. The lower surface of the tarsus also bears short fine hair.

The Mesothoracic Legs.—The middle legs are longer than the front ones. The coxa and trochanter are more or less similar to those of the front legs but the femur is narrow and elongated. The

femur bears a slight groove on its lower margin for the reception of the tibia but it does not make a perfect fit as in the fore-legs. The tibia is about as long as the femur and bears numerous stout spines. Both the upper and the lower margins of the tibia are fringed with long fine hair. At its distal end the tibia bears a short blunt spur bearing a cluster of spines. The tarsus is three-jointed in the adult but only single jointed in the nymph and bears a pair of claws. These legs are purely ambulatory.

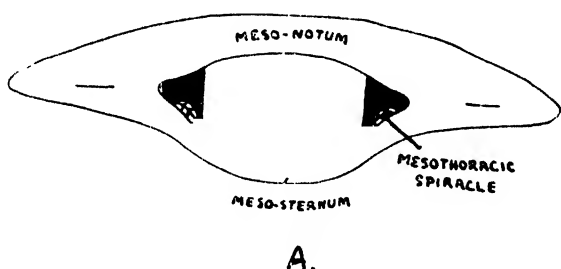
The Metathoracic Legs.—The hind legs are the longest, and all the segments are generally like those of the middle legs. Distally the lower margin of the femur bears long fine hair which is continued all along the margin of the tibia and tarsus and it serves the insect in swimming, as the insect uses its hind-legs as a pair of oars in the water. In *Belostoma* the hind tibia is flattened for the same purpose. The distal end of the tibia bears a spur like the one on the mesothoracic tibia but longer and provided with a thick cluster of spines. The insect is often seen to brush the tip of its abdomen with its hind-legs in order to remove the air bubbles coming out of the sub-elytral space, and the spiny spurs aid in the process. In the nymph the spurs are used to break the film of air carried on the ventral side of the abdomen when necessary. The tarsus is three-jointed in the adult but only one-jointed in the nymph; it bears two prominent claws.

Belostoma differs from *Sphaerodema* in having the fore-tarsus of the adult two-jointed with only a single long claw. *Laccotrephes elongatus*, *L. grisea*, *Nepa cinerea* and *Ranatra* sp. all have single-jointed tarsi in all the three pairs of legs, but the fore-tarsi bear single claws. Both *Belostoma* and *Sphaerodema* possess three-jointed tarsi on the second and the third pairs of legs. Distant (?) wrongly describes them as two-jointed, the first small segment being apparently overlooked by him.

THE NYMPHAL AIR-FLAPS. In the nymph all the spiracles including those on the thorax are situated on the ventral side. Hence some means is necessary by which the young insect could take the atmospheric air to these spiracles. The ventral side of the thorax of the nymph therefore has developed chitinous "air-flaps" for enclosing air (Text Fig. 9). These are semicircular transparent outgrowths from the meta-epimera, which extend over a great part of the abdomen, reaching to the middle of the fifth abdominal segment. On their distal margins they bear long fine hair and short stout spines. The flaps and the membranes of long hair which project from them enable the insect to imprison a small quantity of air between them and the body. The anterior margins of the

air-flaps lie in apposition to the projecting posterior margins of the flap-like mesosternal epimera, and hence the space enclosed between the former and the abdomen and metathorax is continuous with that between the ventral side of the mesothorax and the latter. In this manner all the ventral spiracles of the nymph open into an air chamber and are thus prevented from being wetted. When the nymphs of *Sphaerodema* are seen swimming about in the water the posterior aspect of the air-store appears as a glistening bead on the ventral side of the abdomen. The purpose of this air is the same as that of the air under the hemelytra of the adult, viz. respiratory.

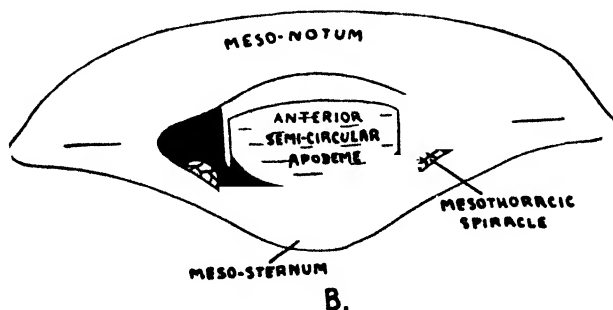
Martin (17) was the first to record these metasternal flaps in the Belostomatidæ. He suggested that besides their preventing the



Text Fig. 6 -Anterior view of mesothorax showing endo Tergite. ($\times 15$).

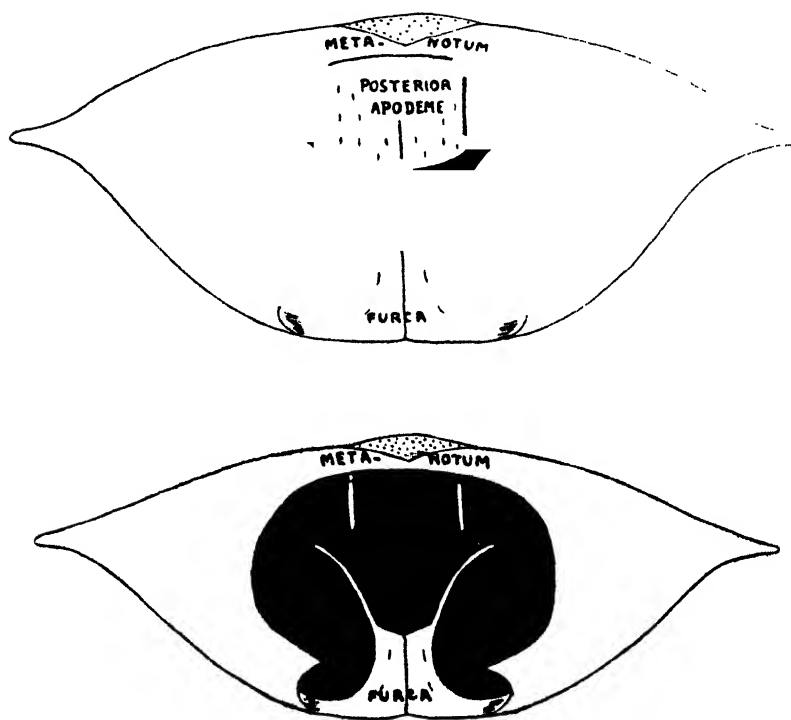
A, degenerate form ; B, normal form.

abdomen from being wetted, they might have a respiratory function like the tracheal gills of the larvae of *Agrion*. But this view cannot be accepted as the tracheal supply of these organs is nothing compared to that of a tracheal gill. That they serve only for enclosing air under the abdomen for the purpose of protecting the spiracles from water and that this stored up air is used by the insect for respiration is experimentally proved and described in another paper (29).



THE ENDOSKELETON OF THE THORAX. Inside the meso- and meta-thorax are found several chitinous pieces which form the endo-skeleton of the thorax. They are developed from the terga, the sterna and the pleura, and are described below under these heads.

The Endotergites.—The anterior margin of the meso-notum is curved down and on the sides meets the slightly turned up anterior margin of the meso-sternum (Text Fig. 6A). In the middle a small opening is left for the internal organs to pass through. In the normal winged form the aperture is further reduced by the development from its dorsal margin of a semi-circular apodeme (Text Fig. 6 B) which projects vertically downwards in the mesothorax. To this phragma the anterior ends of the dorso-longitudinal muscles (tracheo-parenchymatous organs) are attached. From the posterior margin of the metanotum, which lies a little anterior to and below the apex of the scutellum, hangs downwards a broad curved apodeme (Text Fig. 7 B). To this the posterior



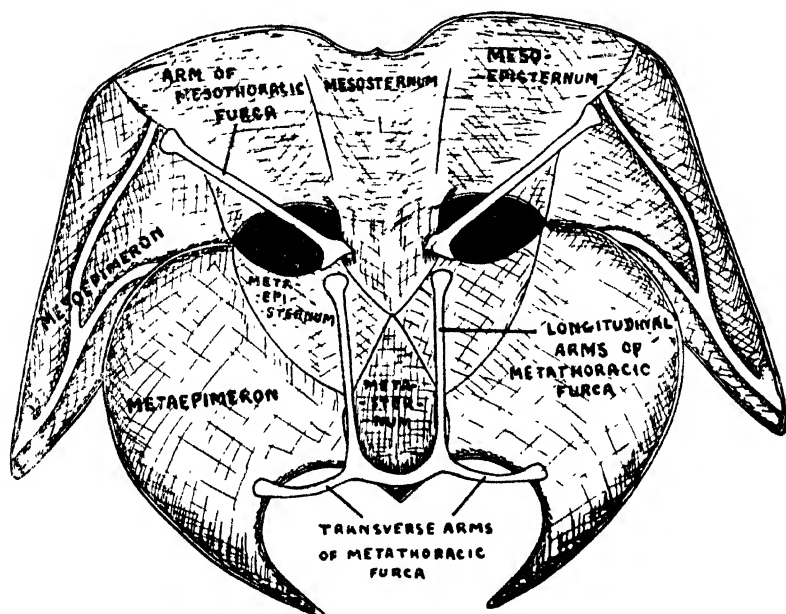
B

Text Fig. 7—Posterior view of meta thorax showing endosternite and furca. (x15) A, degenerate form; B, normal form.

ends of these muscles are attached. From the sides of this posterior apodeme arises a pair of thin apodemes which projects vertically downwards and has their free ends knobbed for the attachment of the posterior ends of the oblique lateral muscles of the mesothorax. Anteriorly these muscles are attached to the ventrally curved anterior margin of the mesonotum. The posterior apodeme and the pair of thin apodemes appear to arise from the posterior portion of the scutellum with which the metanotum is completely fused.

In the degenerate winged form where the tracheo-parenchymatous organs are absent, the anterior semi-circular phragma and the posterior phragma are wanting. In place of the anterior phragma a pair of rod-like apodemes (Text Fig. 6 A) is found indicating the limits of the semi-circular apodeme of the normal form. The pair of thin metathoracic apodemes is however present (Text Fig. 7 A) as in the normal form, though the muscles are wanting.

The Endosternites.—Immediately below the posterior endotergites lies the furca of the mesosternum, which consists of a small basal piece which remains outside the body, and a pair of thin arms projecting towards the meso-epimera (Text Figs. 7 & 8).



Text Fig. 8—Dorsal view of Meso- and Meta-Sterna showing endosternites. ($\times 15$)

The posterior portion of the metasternum bears a well developed furca which possesses two pairs of slender arms; one, a pair of transverse arms forming the upper margins of the coxal cavities, and the other, a pair of parallel longitudinal arms extending upto the mesothoracic furca. The latter affords protection to the mesothoracic ganglionic mass.

The Endopleurites.—The endopleurites consists of two small “jugular sclerites” attached to the pronotum. They give attachment to the prothoracic leg muscles.

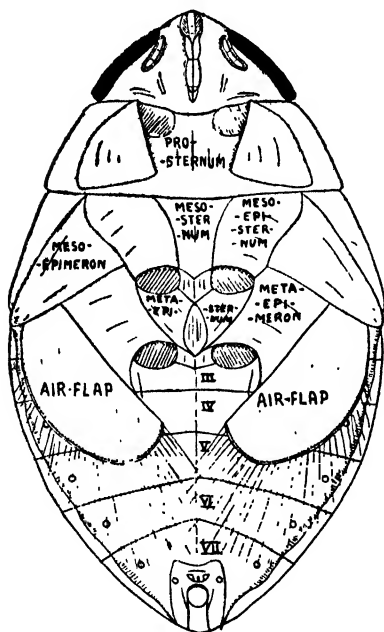
V. THE ABDOMEN

The abdomen of adult *Sphaerodema* is very much concave on the dorsal side and forms a cavity for the storage of air for respiration. In the nymph both the terga and the sterna of the abdomen are convex. The lateral margins of the abdomen in both the nymph and the adult bear short, stout spines and a row of fine hair which help to balance the insect in water.

THE TERGA. The first seven segments of the abdomen only are

visible eternally in the adult. Their terga are thin and transparent and are covered with long hairs which are hooked at the tips. The first segment which is narrower than the second overlaps the latter to a certain extent. The seventh tergum is made up of a median bi-fid and two side pieces.

In the nymph the first nine terga can be distinguished, and the first as in the adult overlaps the second. The eighth is a small horse-shoe shaped tergite and in between the arms of this lies the ninth tergum. The terga are not thin and hairy as in the adult.

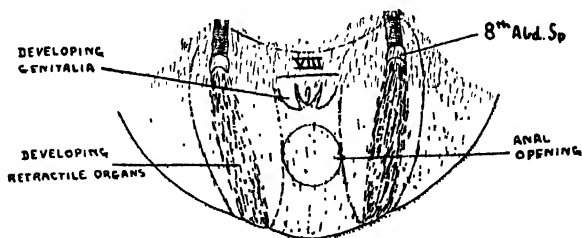


Text Fig. 9—Ventral view of Nymph.

THE STERNA. The sterna of the adult are thick unlike the terga and more chitinized. Six segments, from 2nd to 7th, are

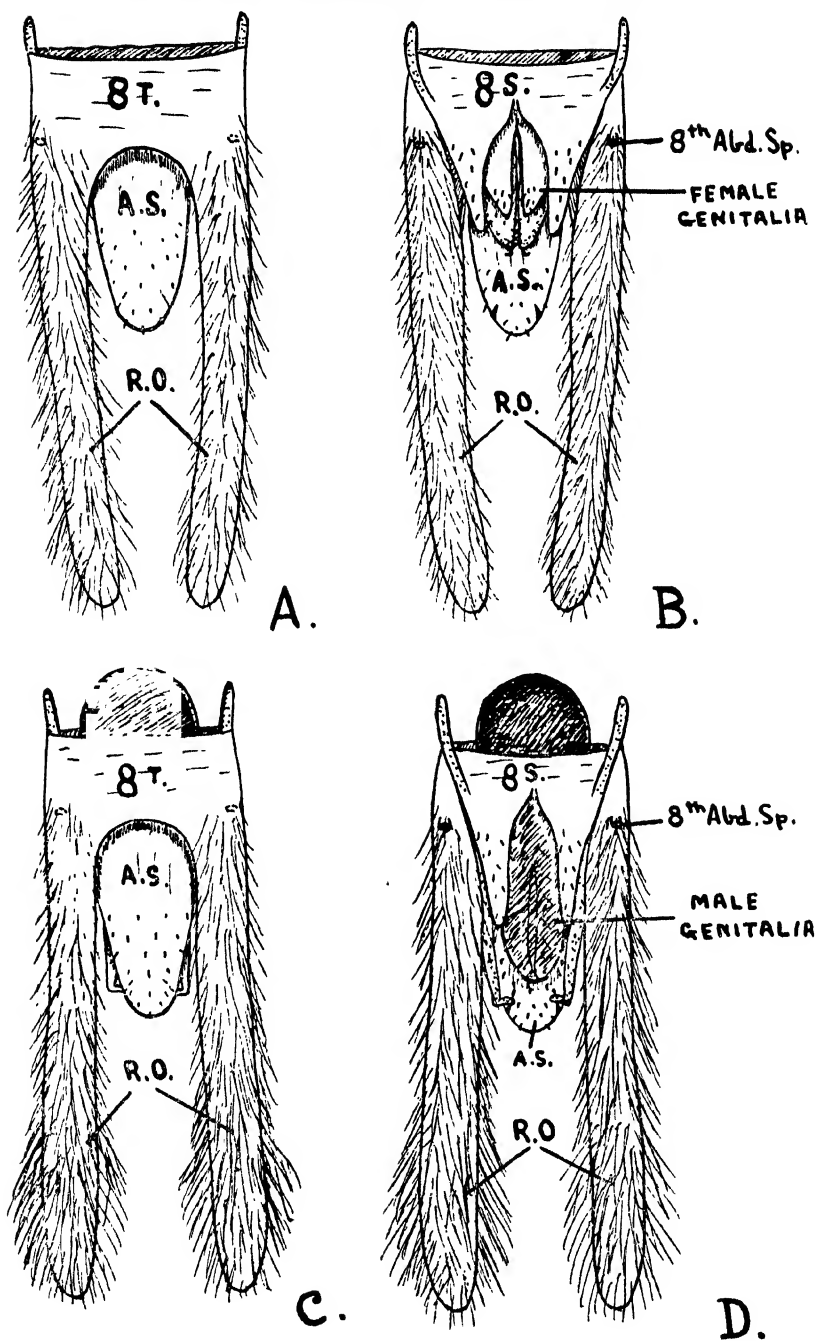
only visible. The first which is present as a membranous piece is entirely hidden by the projecting metasternum. The second sternite is also very much reduced and is visible only as two small triangular marginal pieces. The fifth and the sixth sterna are more or less completely fused, the dividing suture being not distinguishable except towards the margin. The seventh sternum is made up of three pieces like the seventh tergum ; but the middle piece is entire with a rounded posterior margin. A median longitudinal suture divides the sterna 3 to 6 each into two pieces. A longitudinal marginal suture divides each half into two unequal parts. The two marginal sutures extend from the second to the sixth sterna, and meet the inner margins of the lateral pieces of the seventh sternum.

In the nymph sternites two to eight can be made out (Text Fig. 9). Behind the eighth the segmentation is not clear but a large round anal piece represents the tenth segment, while in the fourth and the fifth instars the developing gonapophyses (Text Fig. 10) can be distinguished anterior to the anal piece and this region therefore represents the ninth segment. The nymphal sterna are thin and covered with long hooked hair all over the surface.



Text Fig. 10—Hind view of the abdomen of the Nymph in the fifth stage (Ventral view showing developing genitalia and retractile organs).

THE RETRACTILE ORGANS. Two strap-shaped organs (Text Fig. 11. R. O.) which can be retracted into the hind region of the abdomen are characteristic of the family Belostomatidae. The straps bear long hydrofuge hair directed backwards. Ventrally at the base of each of these opens the last (eighth) abdominal spiracle. From observations on nymphal development we conclude that the major portion of the eighth segment is utilized in the formation of the retractile organs. In the nymph the eighth segment, as described above, is horse-shoe shaped, and the arms of this horse-shoe reach the tip of the abdomen (Text Fig. 9). Between these arms develop the genital and anal segments. The future

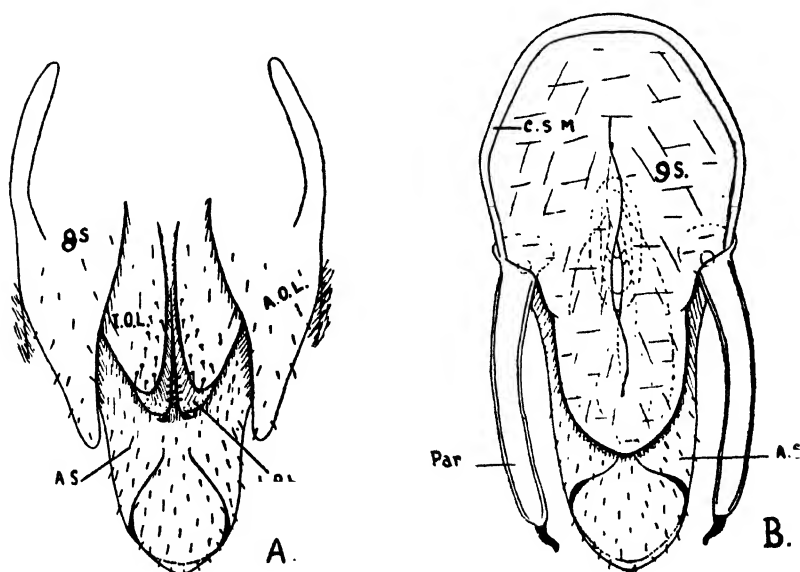


Text Fig. 11 —Retractile Apparatus (including the Retractable Organs, Genitalia and Anal Segment). $\times 22$ A, Female (dorsal view); B, Female (ventral view) C, Male (dorsal view); D, Male ventral view).

retractile organs grow inside these arms and at the last moult they come out in their typical form. The retractile organs are therefore not appendages of the eighth segment but the drawn out lateral parts of the eighth segment itself. Anteriorly the tergum of this segment is represented only by a membranous piece connecting the two straps, while the sternum consists of two triangular pieces which support the genitalia. Bueno (3) described the origin of these "retractile strap-like appendages" in the Belostomatidae as: "the lengthened peritreme of the sixth abdominal spiracles". By "sixth" of course he meant the last pair of spiracles.) For the Nepidae he says: "the two halves (of the siphon) are nothing but the lengthened peritreme of the seventh pair of abdominal spiracles". Hamilton described the siphon of *Nepa* as the prolonged paratergites of the eighth segment. Our observations are therefore not in agreement with those of the above authors.

THE ANAL SEGMENT AND THE GENITALIA. Between the two retractile organs are seen the genitalia, covered dorsally by the anal segment (Text Fig. 11). The anal segment is a narrow elongated cylindrical structure at the termination of which opens the anus. The distal half of the segment is covered with short fine hair.

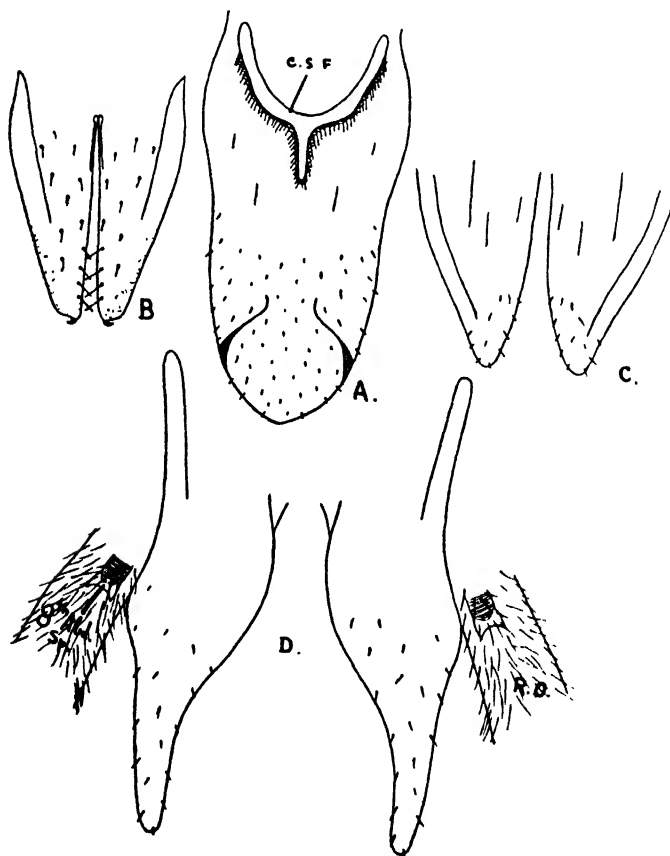
The Female Genitalia.—The ovipositor is insipient and consists only of two pairs of short triangular plates protected ventrally by the two triangular anterior sternites of the modified eighth segment (Text Figs. 11 B and 12 A). The plates are on the whole



Text Fig. 12—Genitalia (ventral view). $\times 33$. A, female, B, male.

feebly chitinized, the well chitinized region being limited to the outer borders. Between the ovipositor and the anal segment is a forked chitinous piece (C. S. F. Text Fig. 13 A) which affords attachment to the genital plates on its ventral side and to the anal segment on its dorsal side. The dorsal plates, the lateral ovipositor lobes, are longer than the ventral plates, the inner ovipositor lobes. Each lateral ovipositor lobe bears at the tip a small outwardly curving chitinous hook. The inner margins of these lobes bear interlocking hair. The inner ovipositor lobes are broader and more membranous than the lateral. There are no anterior ovipositor lobes, unless the two anterior sternal pieces of the eighth segment are regarded as representing them.

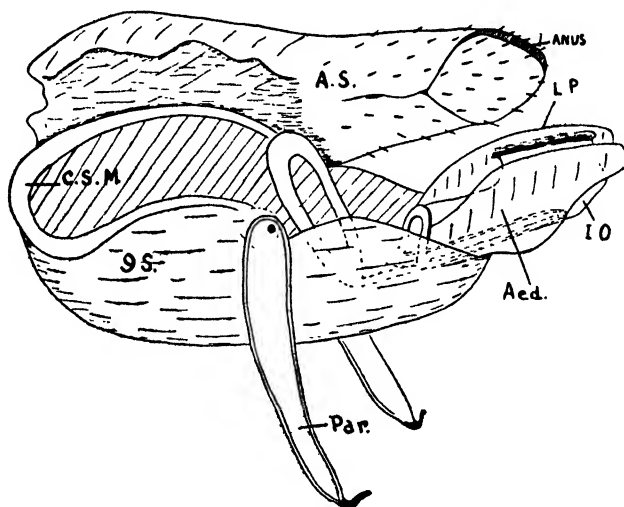
The Male Genitalia.—The male genitalia are formed by the ninth segment (Text Figs. 11 C and D, 12 B, and 14). The



Text Fig. 13—Parts of Female Reproductive Organs. $\times 33$. A, Anal segment
B, Lateral ovipositor lobes ; C, Inner ovipositor lobes ;
D, Anterior ovipositor Lobes.

sternum of the ninth segment forms a hollow boat-like structure. This is found to be made up of a pair of plates. Anteriorly this structure is attached to the base of the anal segment by a curved chitinous rim, which corresponds to the forked chitinous support of the female. The parameres are hinged on the outer side of the boat-like structure to the ends of this chitinous rim. Inside the boat-like structure lies the aedeagus.

The aedeagus (Text Fig. 14, Aed.) consists of two lateral leaf-like plates (L.P.) and a median short stout intromittent organ (I.O.) The entire structure is supported ventrally by a chitinous rod which at the anterior end is continued into a large stout chitinous ring at

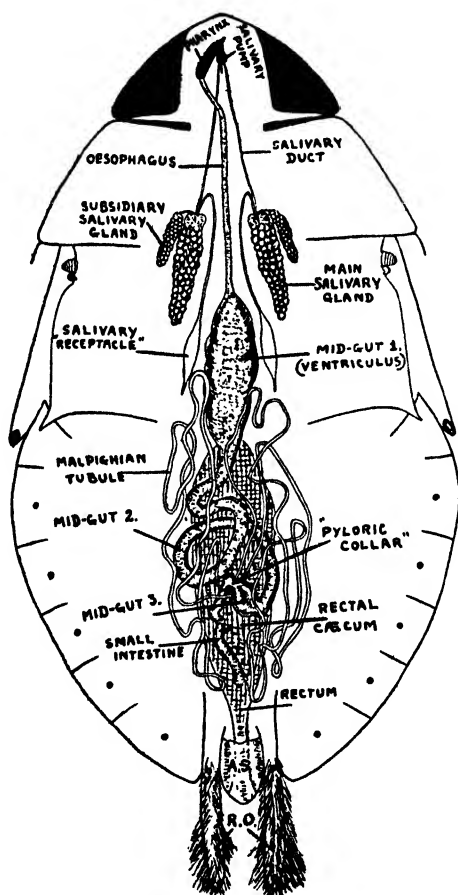


Text Fig. 14—Parts of Male Reproductive Organs. (Lateral view of Anal Segment and Genitalia). $\times 33$.

right angles to the rod. The protractor muscles of the aedeagus are attached to the dorsal part of this ring. Posteriorly the ventral chitinous rod bifurcates. The two arms bend dorsally upon themselves and form the ventral supports of the lateral leaf-like plates of the aedeagus. These arms are then continued forwards and they converge into a smaller vertical ring lying just behind the larger one. This smaller ring forms the base of the intromittent organ. The two rings and the chitinous rods are connected with one another by membranes. The stout intromittent organ is knobbed at the tip and the gonopore opens on its dorsal side by a slit. The lip bounding this opening is thickly covered with short fine hair.

V. THE DIGESTIVE SYSTEM

THE FORE-GUT. The fore-gut (Text Fig. 15) extends into the mesothorax and consists of the pharynx and the oesophagus. The suction canal of the maxillary stylets leads into the chitinous pharynx which lies immediately below the clypeus. It is supported ventrally by a strong chitinous trough, the so-called fused anterior arms of the tentorium, suspended from the sides of the clypeus. The dorsal wall of the pharynx bears on the outside a median longitudinal row of fine long setae. In transverse section the dorsal wall is W-shaped (Pl. II. Fig. 14) and between this and the clypeus lie the pharyngeal muscles.



Text Fig. 15—The Digestive System.

The oesophagus is very long and narrow and is somewhat elastic. The epithelial lining of the oesophagus is made up of elongated cells with a chitinous intima (Pl. II. Fig. 13). The muscular wall is made up of an inner circular and outer longitudinal layers of muscles.

THE MID-GUT. The mid-gut is divided into three distinct regions, a large sac-like anterior ventriculus, a coiled tubular middle portion, and a small posterior rounded chamber. In a transparent living specimen of the insect the ventriculus may be occasionally seen to contract peristaltically. The epithelial lining of this part of the alimentary canal shows groups of columnar secreting cells (Pl. II. Fig. 15). At the base of each group are a few small cells clustered together. These are the regenerative or "nest" cells (Pl. II. Fig. 15, N.C.). An inner layer of circular and an outer layer of longitudinal muscle fibres lie on the outside. A basement membrane lies outside the epithelial layer, and a peritoneal membrane covers the muscular layer.

The middle region of the mid-gut, the narrow coiled tube lying in the abdominal region, has a structure similar to that of the preceding one.

In the terminal portion of the mid-gut, the swollen rounded chamber, are frequently found collected small fine particles of a dark brown colour. A narrow "pyloric collar", connects the mid-gut to the hind-gut, and into this region opens a pair of Malpighian tubules.

THE HIND-GUT. The mid-gut opens into the hind-gut laterally at its anterior end. The anterior region of the hind-gut is distinguished as the small intestine. It is a straight short tube which opens behind into a thin-walled rectal caecum. The epithelial lining of the small intestine is very peculiar and resembles somewhat the lining of the large intestine of mammals (Pl. III. Fig. 16). The entire epithelium with its basement membrane is thrown into convolutions. The epithelial cells are elongated and bear large oval nuclei, and their cytoplasm is striated. The muscular lining of the wall is very thin. Only a few thin longitudinal fibres can be made out. The epithelial tissue is penetrated by a few fine tracheoles (Pl. III. Fig. 16). Poisson (26) had noted such intracellular tracheae in *Nepa*. Hamilton (11) disagreed with him and maintained that they were only "small round holes". It is a misapprehension on the part of Hamilton, because Poisson noted these small holes in addition to the intracellular tracheae: "Entre ces trachées s'observent de nombreuses vacuoles". His figure xvi

also indicates both the tracheae and the vacuoles. Oblique sections clearly reveal tracheoles penetrating the epithelial tissue (Pl. III. Fig. 16).

Along one side of the anterior portion of the small intestine the epithelial lining is thrown into numerous folds and grooves (Pl. III. Fig. 16, T. R.). Hamilton (11) has referred to this in *Nepa* as the "pigmented streak". It is at this region the hind-gut runs into the mid-gut as shown in serial sections. The peculiar epithelium of this region therefore represents a transition between the small intestine and the mid-gut.

THE RECTAL CAECUM. A very thin-walled large sac filled with liquid contents is conspicuous on dissecting a fresh specimen of the insect. This is the rectal caecum which extends from the hind region of the abdomen right upto the thorax when fully distended. The liquid is sometimes clear but at other times it is of a dark colour with suspended granules. The histological structure of the epithelial lining of the caecum (Plate III. Figs. 17 and 18) shows numerous folds and grooves and resembles somewhat the epithelium of the transitional region described above. The cells have small oval nuclei. The wall is bounded by prominent strands of muscle fibres, the inner circular and the outer longitudinal, arranged in regular rows which in preparations of the entire caecum give a checkered appearance to the wall. The structure of the caecum of *Sphaerodema* does not resemble that of the caecum of *Nepa* as described and figured by Hamilton. She describes the muscular wall as possessing an inner layer of longitudinal and an outer layer of circular muscles, which is opposite to what we find in *Sphaerodema*.

In a living insect the caecum is found to contract rhythmically once for every two beats of the heart. This regular rhythmic movement naturally suggests a respiratory or circulatory function. Many previous investigators have tried to explain this action of the caecum in other aquatic bugs. But none has so far been able to do so satisfactorily. There is no doubt that the caecum is somehow correlated with the aquatic habits of the insect, as it is found only in aquatic species of the Hemiptera. Poisson (26) allotted a hydrostatic function to it, while Portier (27) suggested that it functioned as a "lavage rectale", an adaptation to aquatic life. But these suggestions do not explain the very regular contractions that the caecum presents. Poisson also suggested another function, that of a defensive organ. It is true that the insect ejects a jet of liquid at times when disturbed, but that occurs very rarely and it does not account for its regular contractions.

The tracheal supply is not such as would suggest any direct respiratory function like that of a tracheal gill. The thin membranous wall of the caecum may help to diffuse oxygen from the water in the caecum into the blood in the haemocoel. The rhythmic action may produce a current of water in and out of the caecum and may make such a diffusion of gases possible. An inward current of water has not however been noticed and as such it does not seem to be its correct function.

In another way the caecum may help respiration, as we have suggested in another paper (29). Its rhythmic contractions may be a contrivance to ventilate the tracheal trunks and be a more efficient one than the beating of the heart or the peristalsis of the alimentary canal.

THE RECTUM. The rectal portion of the alimentary canal is similar in appearance to the caecum. But transverse sections reveal that the dorsal half of its wall bears the structure of the small intestine while the structure of the ventral half is like that of the caecum. A section through the junction where the small intestine passes into the caecum is shown in Plate III Figure 19.

THE SALIVARY GLANDS. A pair of salivary glands lies in the anterior region of the thorax. Each gland is composed of a main salivary gland, a subsidiary salivary gland and the so-called receptacle. The main gland (Text Fig. 15) is an elongated organ made up of numerous small rounded lobes or acini arranged round a central duct. The acini are smaller towards the distal end of the gland. At the proximal end of the main gland is a large bilobed thin-walled sac containing a milky fluid. It is easily burst open at the slightest touch, and the fluid flows out. As the fluid is saliva this sac probably functions as a salivary receptacle. The subsidiary gland is similar though much smaller than the main gland, and its component acini are also smaller than those of the latter. Besides, the subsidiary gland does not possess thin walled sac at its anterior end like the one present on the main gland. A short duct issues out of the subsidiary gland and opens into the sac of the main gland. A small flattened oval organ the so-called receptacle, lies a little behind the main gland. Its long narrow duct runs forward and curves back to enter the sac of the main gland at the point where the duct of the subsidiary gland enters. It is not certain if this organ really serves as a receptacle. The salivary duct issues out of the main gland and continues upto the head where it unites with its fellow of the opposite side before opening into the base of the salivary syringe.

Transverse sections of the glands are shown in Plate II Figures

8 and 9. Each acinus is a single large cell having a peripheral protoplasmic region with two or three large nuclei and a large central vacuole containing the secretion of the cell (Plate II. Figs. 11 and 12). The secretions of the two glands seem to be different. It is so also in *Nepa* and from the nature of these secretions Hamilton (11) suggests that they may combine to produce a reaction similar to that of the acid and alkaline secretions of the poison glands of the wasps, etc. The secretions of the two glands do mix in the two white lobes at the anterior end of the main gland, and there is a common duct which carries the saliva to the rostrum. The duct is made up of a single layer of small cubical cells (Pl. II. Fig. 10.)

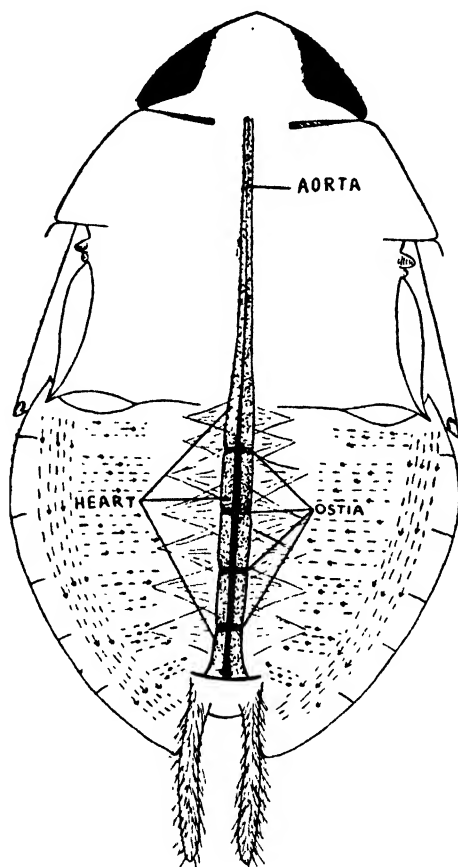
THE MALPIGHIAN TUBULES. The malpighian tubules (Text Fig. 15) appear to be four in number but a closer examination reveals that as in *Nepa* they are only two very much coiled long narrow tubes which open into the alimentary canal at the "pyloric collar" by both their ends. In transverse section (Pl. II. Fig. 7) a tubule is found to be made up of a single layer of large epithelial cells with large oval nuclei. On the internal and external borders of each cell are marked out narrow zones of striations representing the pore canals and canaliculi. A peritoneal membrane surrounds the tube.

VII. THE CIRCULATORY SYSTEM

THE DORSAL VESSEL. The dorsal blood vessel is distinguished into a thick-walled heart lying in the abdomen and a narrow thin-walled aorta in the thoracic region (Text Fig. 16). Four pairs of ostia divide the heart into five chambers. Anteriorly it narrows into a thin vessel, the aorta, which terminates in the head. The heart lies in the dorsal sinus suspended from the abdominal terga. Seven pairs of alary muscles are attached to the heart. Rhythmic contractions of the heart take place in a flowing movement from behind forward pumping the blood in a forward direction. In the tibiae of all the legs are noticed secondary pulsating organs which aid the circulation of blood.

THE BLOOD AND CIRCULATION. The flow of blood can be observed in a transparent living specimen in the abdominal region. Blood travels backwards in the margins of the abdominal cavity and in each segment some blood is diverted inwards, entering the heart through the ostia at every diastole. At systole, the blood in the heart is carried forwards through the aorta to the head sinuses. The blood has a greenish colour and the walls of the heart therefore appear green.

Muttkowski (21) demonstrated the presence of a respiratory protein with a copper nucleus, in the blood of insects. To insect



Text Fig. 16—The Circulatory System. Arrows show the circulation of blood in the abdominal cavity.

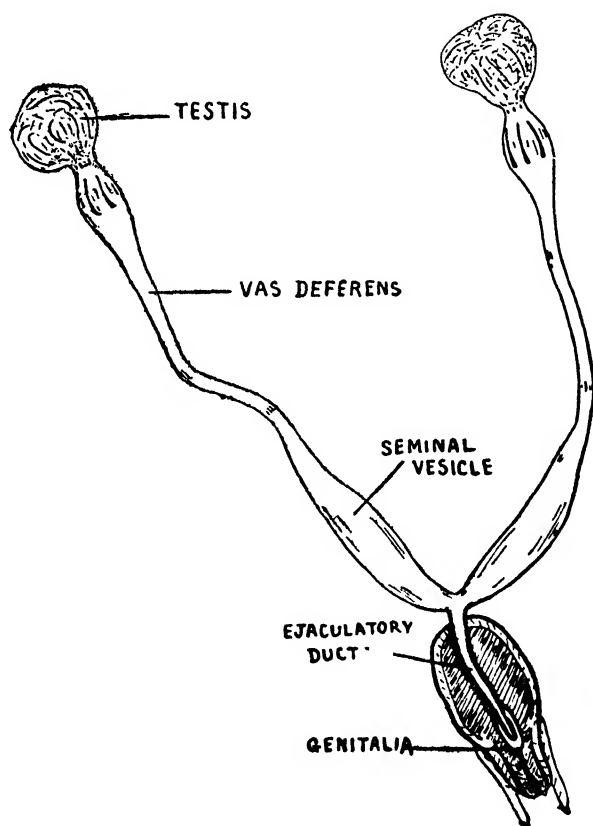
blood, which has hitherto been regarded as having nothing to do with respiration, has thereby been attributed a respiratory function also.

VIII. THE REPRODUCTIVE SYSTEM

The sexes are similar in external appearance and it is very difficult, though not quite impossible, to distinguish a male from a female, on superficial examination. The only sign of distinction is the slightly more bulged out abdomen of the female. But a female

bearing eggs has a conspicuously bulged abdomen and the eggs inside can be readily made out through the transparent body wall.

THE MALE REPRODUCTIVE ORGANS. The testes (Text Fig. 17) are rounded bodies each composed of a tangle of five seminal tubules lying ventrally in the lateral region of the third abdominal segment. They are richly supplied with tracheoles from the short second spiracular tracheae of the abdomen. The seminal tubules are enclosed in a single scrotum and can be separated out by tearing open this investing membrane.



Text Fig. 17—The Male Reproductive System. $\times 11$.

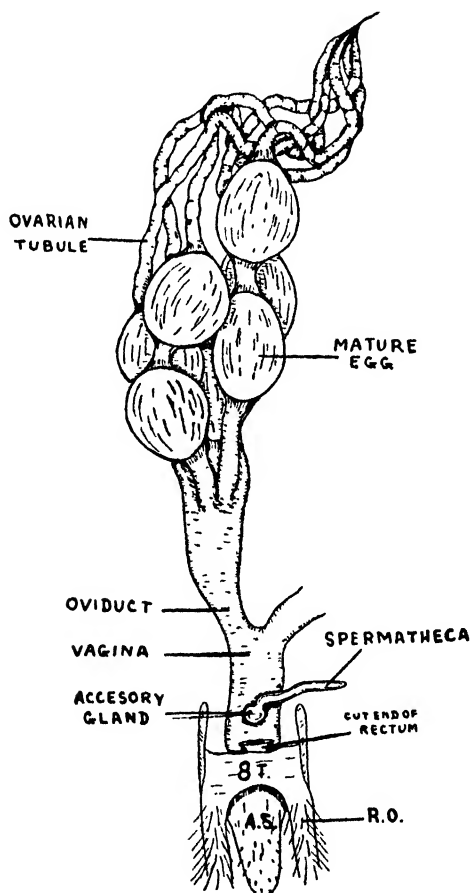
The two vasa deferentia unite posteriorly to form the narrow ejaculatory duct which leads into the aedeagus. The posterior parts of the vasa deferentia are enlarged to function as vesicula seminalis.

The male organs of *Sphaerodema* differ from those of *Nepa cinerea*, in which the vasa deferentia are long, narrow, much coiled

tubes and at the base of each opens a coiled seminal vesicle (vide Hamilton.) In *Ranatra fusca*, according to Marshall and Severin (vide Imms (14) p. 342.), the two vesicula seminales are as in *Sphaerodema* simply the enlarged posterior parts of the vasa deferentia. The seminal tubules are however six in number in that insect.

The seminal tubules, vasa deferentia and seminal vesicles contain masses of coiled spermatozoa with very long tails (Pl. II. Fig. 3.)

THE FEMALE REPRODUCTIVE SYSTEM. Each ovary (Text Fig. 18) is made up of five long thin-walled ovarian tubules or ovarioles which extend right upto the prothorax. The ovaries like the testes are also supplied with numerous tracheoles from the second spiracular tracheae. The free fine ends of the ovarian



Text Fig. 18—The Female Reproductive System. $\times 11$.

tubules unite into a fine terminal filament. Posteriorly the five tubules open into a broad egg calyx which receives the ripe eggs before they pass into the oviduct which is very short. The oviducts of the two sides unite to form the median vagina. Dorsal to the vagina is situated a small elongated sac, the spermatheca. Posterior to the opening of the spermatheca and very close to it is a small round accessory gland.

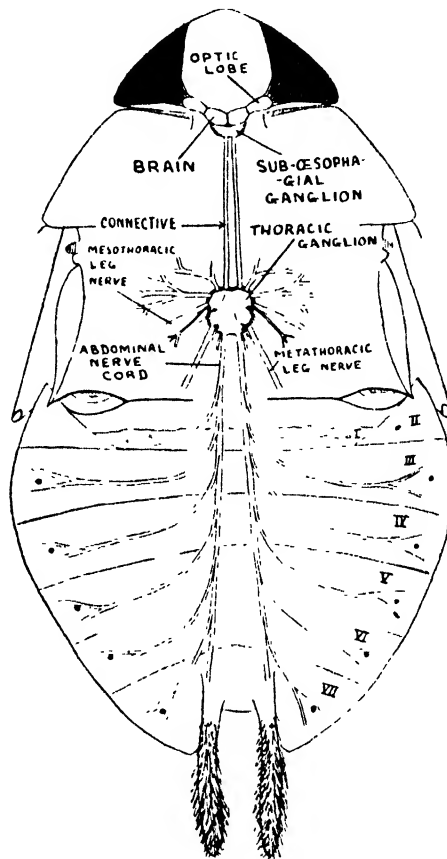
Each ovariole is divided into three regions: (1) the terminal filament which unites with the others and attaches the ovary to the prothorax; (2) the terminal chamber or germarium with undifferentiated cells; and (3) the posterior main division, the vitellarium, containing the developing and ripe eggs. The last portion is constricted into a number of follicles, each of which contains a single ovum. This gives the ovariole a beaded appearance. The ovarioles are typically Rhynchotan being of the acrotropic type carrying the nutritive cells in the terminal chamber.

Plate II Figure 4 is a transverse section through a follicle showing a large ovum surrounded by small follicle cells. Plate II Figure 5 is a transverse section of the anterior portion of an ovariole with young developing ova surrounded by follicle cells. The oviduct is made up of a single layer of small epithelial cells and two layers of muscles, the inner longitudinal and the outer circular (Pl. II. Fig. 6).

IX. THE NERVOUS SYSTEM

The concentration of the nervous system (Text Fig. 19) in *Sphaerodema* is like that in *Nepa*. All the ventral ganglia are fused together in two masses situated in the thorax. The first of these is situated almost in the neck region and is formed by the fusion of two ganglia—the suboesophageal and the prothoracic. This we shall refer to as the suboesophageal ganglion. The other lies in the posterior region of the mesothorax and is a composite of the mesothoracic, the metathoracic and all the abdominal ganglia. This will be referred to as the mesothoracic ganglion. The brain lies immediately above the suboesophageal ganglion and is connected to it by two very short, stout connectives, leaving a small opening for the oesophagus to pass through. A double connective joins the suboesophageal ganglion to the mesothoracic ganglion. From the latter two ventral nerve cords run into the abdomen. Apparently two stout nerves proceed to the last segment of the abdomen giving out branches to the abdominal segments. But actually these two are made up of several fine nerves which run together in two bundles. The outermost of these nerves run with

the bundles only upto the first abdominal segment and then separate out to supply the first two abdominal segments. Each succeeding segment is supplied with a pair of nerves which separate out of these bundles at regular intervals.



Text Fig. 19—The Nervous System.

THE BRAIN. The small bilobed brain lies in the posterior-most region of the head, almost in the neck. It bears on the sides two optic lobes which are slightly smaller in size than the lobes of the brain. The optic lobes give out a number of fine nerves to the eyes. From the brain a pair of nerves are supplied to the antennae. In sections the brain shows two distinct regions—the outer cellular region made up of ganglion cells, and the central medulated region made up of fine fibres and a granular substance. The mushroom bodies found in more intelligent insects like the honey-bee are (as in *Nepa*) absent in *Sphaerodema*.

THE SUBOESOPHAGEAL GANGLION. The suboesophageal ganglionic mass, made up of the suboesophageal and the prothoracic ganglia, is a pear-shaped body lying close below the brain in the neck and is connected to the brain by short stout connectives. The connectives are so short that the whole mass appears as one with a small opening for the oesophagus to pass through. Three pairs of nerves are given off anteriorly by the suboesophageal ganglion to the mouth parts. From the posterior portion of the ganglion arises a pair of nerves which supplies the prothoracic legs. Two stout connectives running posteriorly join the mesothoracic ganglion.

THE MESOTHORACIC GANGLION. Three distinct regions can be marked out in this ganglionic mass; the anterior region represents the true mesothoracic ganglion, the middle region the metathoracic, and the posterior region represents the abdominal ganglia, as these supply nerves to the respective parts of the insect.

From the anterior region four nerves arise on each side. The first divides into two and supplies the ventral anterior region of the mesothorax. The second runs laterally to the wing and the leg muscles of the mesothorax. The third is stouter than the first two and supplies the mesothoracic legs. Another very slender nerve has its origin near the last one. The middle region of the ganglion gives out three pairs of nerves. The first two of either side are very fine and they innervate the muscles of the metathorax. The third is a stout nerve which goes to the metathoracic leg. The posterior region of the ganglion sends out a number of fine nerves. The first two pairs are distinct; the others unite to form the two ventral nerve cords. These bundles originate close together from the posterior end of the ganglion and diverge to the hind end of the abdomen. A pair of nerves runs out from the bundles in each of the visible abdominal segments and a pair is supplied to the anal and genital segments. These individual nerves can easily be separated from the bundles right upto the ganglion, thus indicating their independent entity.

THE TRACHEAL SUPPLY OF THE NERVOUS SYSTEM. The tracheae not only supply oxygen to the nervous tissue but also keep the ganglia in their places. The main tracheal trunks enter the head and give out branches to the brain. A pair of diagonal tracheae in the prothorax forms a cross below the suboesophageal mass and from these, tracheoles penetrate into the ganglion. Similarly a pair of diagonal tracheae in the mesothorax forms a cross ventral to the mesothoracic ganglion and send out tracheoles to the anterior ventral region of the ganglion and to the anterior

nerves. From the posterior end of the cross a pair of tracheae ramifies into the dorsal anterior region of the ganglion. The transverse ventral trachea of the mesothorax interlaces with the posterior portion of the ganglion and the nerves of that region. It sends out a pair of ramifying tracheae to the ventral posterior side of the ganglion, and another pair to the dorsal side, and tracheoles to the various nerves. The ventral commissural tracheae of the abdomen supply tracheoles to the abdominal nerves.

THE SENSE ORGANS. Scattered on the body of the insect are found rounded disc-like specialisations of chitin. These are innervated by nerves and are to be regarded as sensillae. They are of general occurrence in the Rhynchota. They show some variations in their shape and arrangement in the different families. Their nature and distribution might be of taxonomic value. Besides these there are short stout sensory spines on the legs, on the margins of the abdomen, on the margins of the air-flaps, etc. These spines show longitudinal ridges. A third kind of sense organs found in this insect are long fine bristles or hair also found on the legs and air-flaps etc. Flattened sense scales described by Hamilton in *Nepa* are wanting in *Sphaerodema*. It is doubted whether the flattened scales noted by her are only the sensillae described above. We have not found any scaly nature in these sensillae.

X. SUMMARY

1. The general habits and life-history of the bug are given.
2. The morphological structures of the head, the thorax and the abdomen, and their appendages are described in detail.
3. Certain endotergites are absent in the degenerate winged form. These endotergites are those used for the attachment of the dorso-longitudinal indirect wing muscles in the normal winged form.
4. The tarsi of the second and the third pair of legs are three-jointed in the adult and not two-jointed as described by Distant.
5. The sides of the eighth abdominal segment are prolonged into strap-shaped organs which are retractile. They carry the last pair of spiracles on their bases. The development of these organs is noted. These organs are found to be homologous and analogous to the respiratory siphon of the *Nepidae*.
6. The anatomy of the digestive, circulatory, reproductive and nervous systems is worked out and the histological structures of the various organs are given.

7. To the prominent rectal caecum found in *Sphaerodema* and other aquatic bugs is ascribed the function of ventilating the tracheal trunks. This has been suggested on account of the rhythmic contractions it manifests.

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XII. EXPLANATION OF THE PLATES

Plate I Fig. 1. Dorsal view of adult *Sphaerodema*.

Plate II Fig. 2. Antenna. (X33).

Fig. 3. Coiled Spermatozoa from Seminal Vesicle (X700).

Fig. 4. T. S. of Ovariole through a Follicle. (X150).

Fig. 5. T. S. of Anterior Portion of Ovariole showing Developing Ova. (X700).

Fig. 6. T. S. of Wall of Oviduct. (X700).

Fig. 7. T. S. of Malpighian Tubule. (X700).

Fig. 8. T. S. of Main Salivary Gland of Nymph, (X300).

Fig. 9. T. S. of Subsidiary Salivary Gland of Nymph. (X300)

Fig. 10. T. S. of Salivary Duct. (X700).

Fig. 11. T. S. of Portion of Main Salivary Gland of Adult. (X150).

Fig. 12. T. S. of Portion of Subsidiary Salivary Gland of Adult. (X150).

Fig. 13. T. S. of Oesophagus. (X700).

Fig. 14. T. S. of Pharynx. (X550).

Fig. 15. T. S. of Mid-gut. (X300).

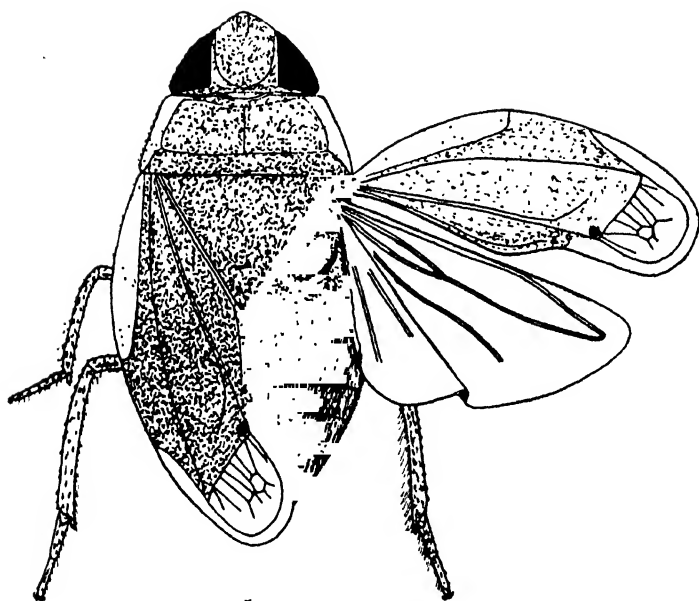
Plate III Fig. 16. T. S. of Small Intestine. (X150).

Fig. 17. T. S. of Rectal Caecum. (X150).

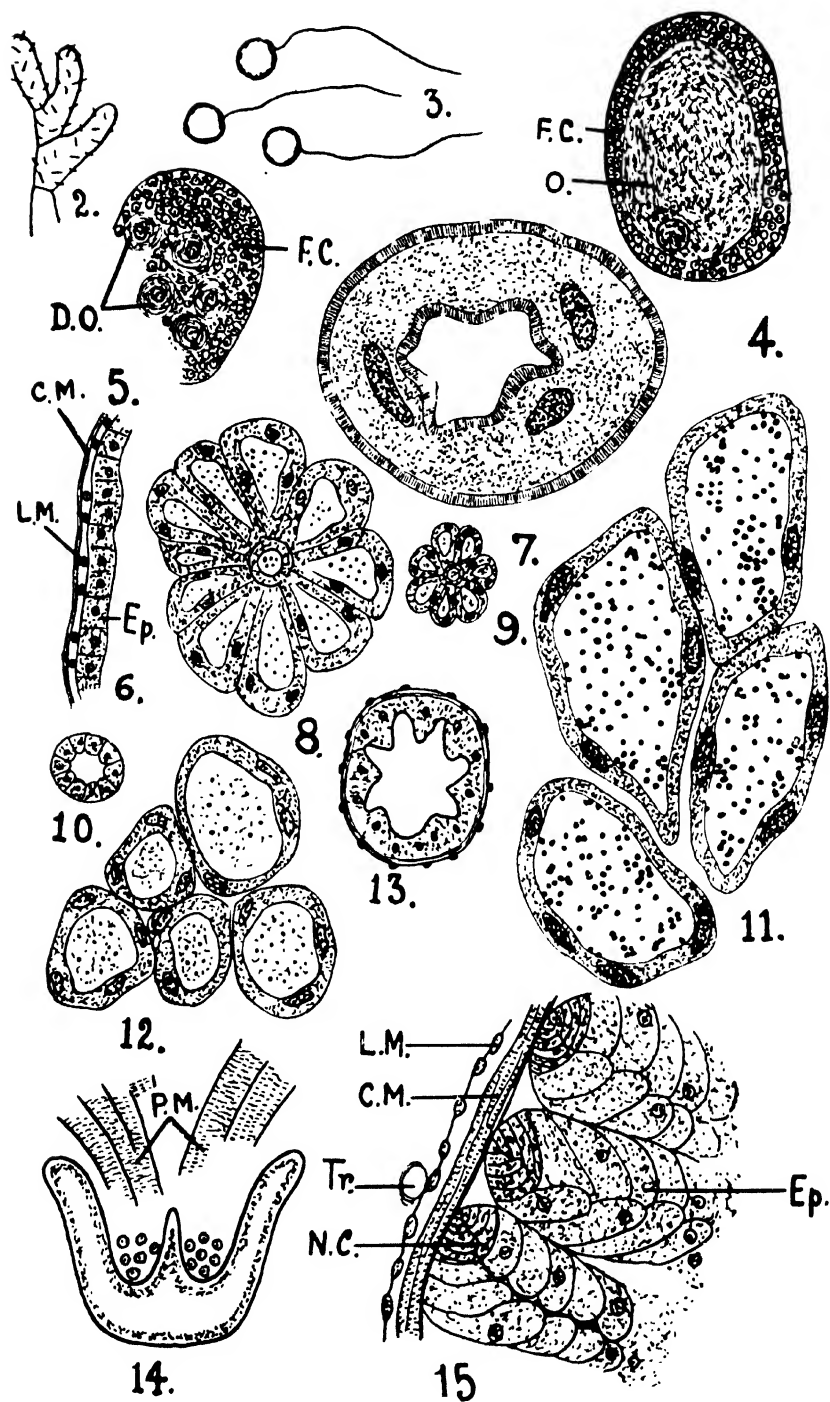
Fig. 18. T. S. of Portion of Rectal Caecum highly magnified. (X550).

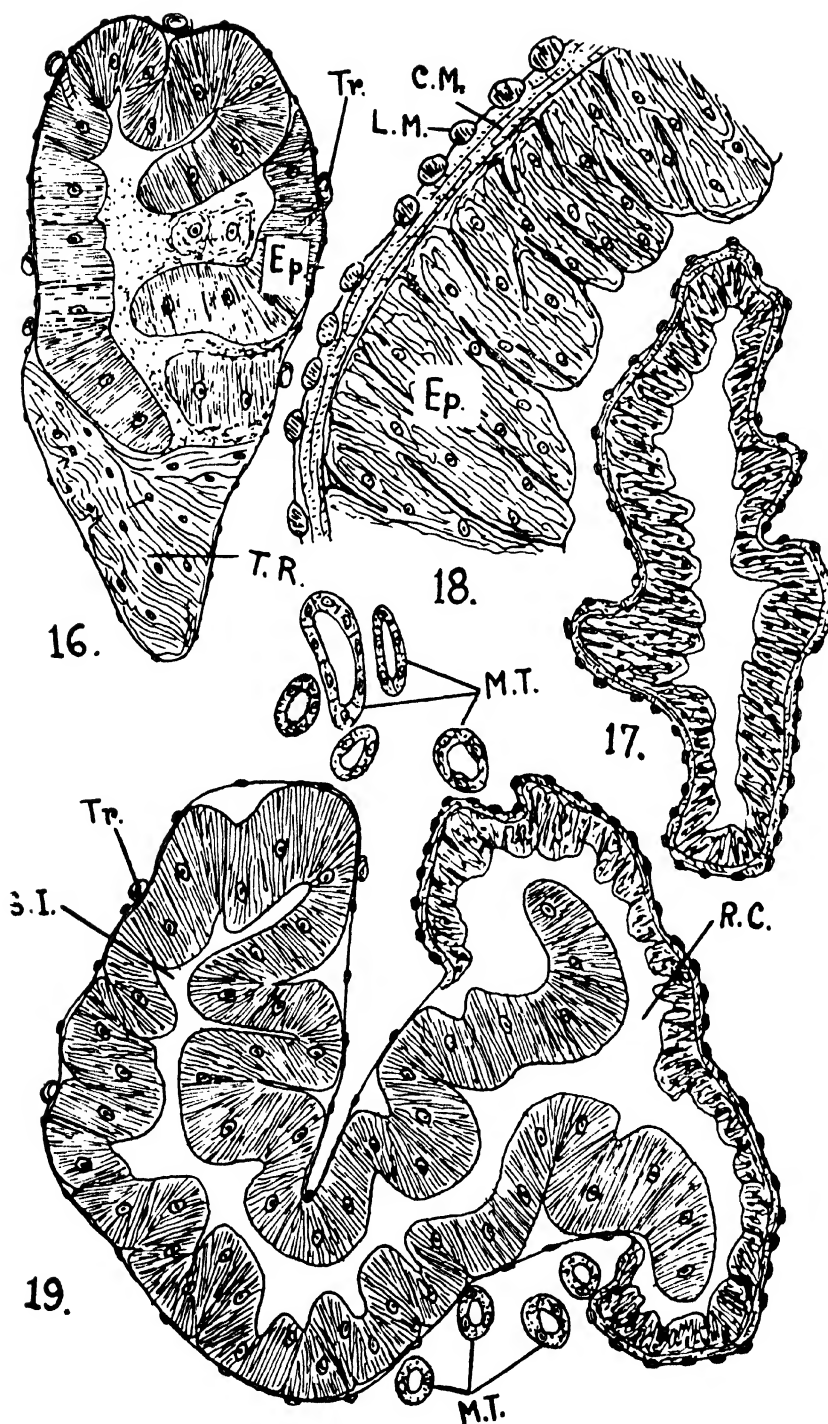
Fig. 19. T. S. of Hind-gut Showing Small Intestine Opening into the Rectal Caecum. (X. 150).

Presswalla & George Plate I



1.





LETTERINGS

I—IX	Abdominal Segments 1 to 9.
1st Abd. Sp.	First Abdominal Spiracle.
8th Abd. Sp.	Eighth Abdominal Spiracle.
Aed.	Aedeagus.
A. O. L.	Anterior Ovipositor Lobe.
A. S.	Anal Segment.
Br.	Brain.
C. M.	Circular Muscle.
C. S. F.	Chitinous Support of Female genitalia.
C. S. M.	Chitinous Support of Male genitalia.
D. O.	Developing Ova.
D. S.	Dorsal Spines.
E.	Eye.
Ep.	Epithelium.
F. C.	Follicle Cells.
I. O.	Intromittent Organ.
I. O. L.	Inner Ovipositor Lobe.
L. M.	Longitudinal Muscle.
L. O. L.	Lateral Ovipositor Lobe.
L. P.	Lateral Plate of Aedeagus.
Md. L.	Mandibular Lever.
Md. S.	Mandibular Stylet.
Ms. G.	Mesothoracic Ganglion.
Ms. Sp.	Mesothoracic Spiracle.
M. T.	Malpighian Tubules.
Mx. S.	Maxillary Stylet.
N. C.	Nest Cells.
O.	Ovum.
Oe.	Oesophagus.
O. L.	Optic Lobe.
Par.	Paramere.
P. M.	Pharyngeal Muscle.
R. C.	Rectal Caecum.
R. O.	Retractile Organs.
8S.	Eighth Sternum.
9S.	Ninth Sternum.
Sub. Oes. G.	Sub-Oesophageal Ganglion.
S. P.	Salivary Pump.
8T.	Eighth Tergum.
Te.	Tentorium.
Tr.	Trachea.
T. R	Transitional Region.
V. S.	Ventral Spines.

THE ALIMENTARY CANAL
OF
THALASSEMA BOMBAYENSIS (PRASHAD AND AWATI).
(With 15 Text-figures)

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The alimentary canal in *Thalassema bombayensis* is a simple narrow tube more or less of a uniform diameter throughout its length. The tube is extremely elastic and gets distended a great deal when food-balls and pellets are passing through it.

The entire canal can be divided into three sections, of which the first and the last sections are almost straight while the middle section is very much complicated and thrown into several loops (Fig. 1).

Each section can further be divided into several parts. The first section beginning with the mouth consists of the pharynx, oesophagus, gizzard and the crop. The middle part which forms a series of loops of successively longer lengths consists only of the intestine which is conveniently subdivided into three parts irrespective of the loops: (a) the pre-collateral intestine (Zwischendarm); (b) the collateral intestine (Mitteldarm); and (c) post collateral intestine (Hinterdarm). Lastly the third section of the alimentary canal which is almost a straight short tube which becomes the rectum or the posterior part of the gut terminating into the anus.

The whole of the alimentary canal is attached to the body-wall by means of several mesenteries (suspensory ligaments), the most important among them being the dorsal mesentery which runs along the whole length of the dorsal surface of the gut except in the region of the pharynx, oesophagus and the gizzard on one hand and the distal part of the rectum on the other. The pharynx and the distal part of the rectum are on the other hand, attached to the body-wall by mesenteries radiating in all directions; while the oesophagus and the gizzard are bound to the ventral body-wall by a pair of sheets of the ventral mesenteries one sheet

on each side of the nerve cord. The portion of the alimentary canal immediately beyond the crop is slung to the body-wall by several mesenteries or ligaments running in different directions in addition to the dorsal mesentery as already mentioned above.

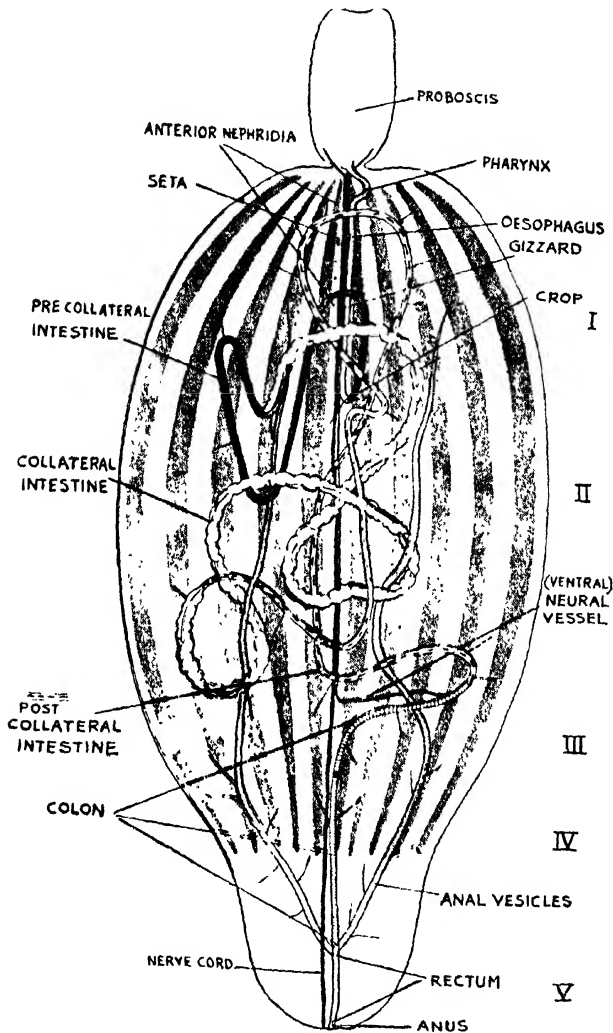


Fig. 1—Dissection of *Thalassema bombayensis* showing diagrammatically several loops of the alimentary canal. $\times 5$

I. THE FIRST SECTION OF THE ALIMENTARY CANAL

1. THE MOUTH. The mouth is situated more or less on the ventral side of the extreme anterior end of the animal at the base of the proboscis which surrounds the aperture and forms a sort of a funnel. The mouth is generally closed in preserved specimens and presents the star shaped appearance due to small furrows. It is surrounded by a strong sphincter muscle made up of broad bands of circular muscles.

2. THE PHARYNX. (Figs. 2 and 3). The mouth leads into a spacious pharynx which is triangular in shape in a cross-section. Externally it is covered over by radiating mesenteric strands by means of which it is attached to the adjoining region of the body-wall. During its course the pharynx is bent a little upon itself.

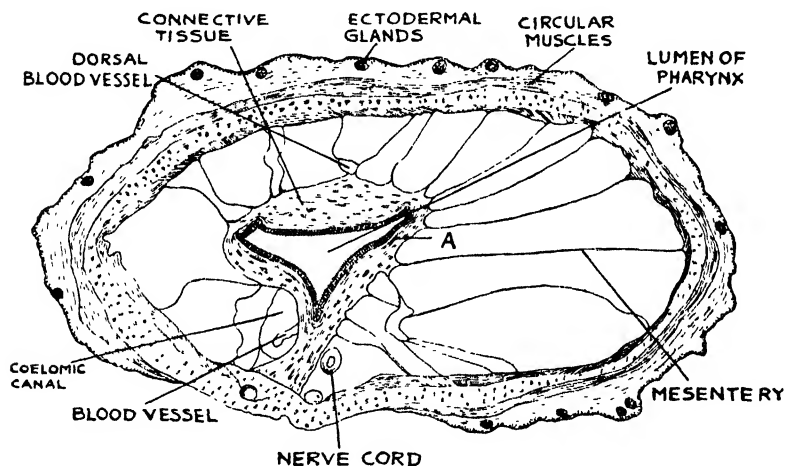


Fig. 2—A transverse section of the Pharynx. $\times 30$

Internally the wall of the pharynx shows a smooth lining, there being no ridges and furrows such as characterise the lining of the succeeding parts of the gut e.g. the oesophagus and the gizzard. In a series of transverse sections, the pharyngeal epithelium is seen to consist of tall cylindrical ciliated cells with the nuclei lying in the centre. The cilia are short and numerous. A few unicellular glands are found embedded in the epithelium and they presumably discharge their secretions into the lumen of the pharynx. The epithelium is surrounded on the outside by many layers of circular muscle fibres embedded in the connective tissue. The outer thick covering of the pharynx is formed by the

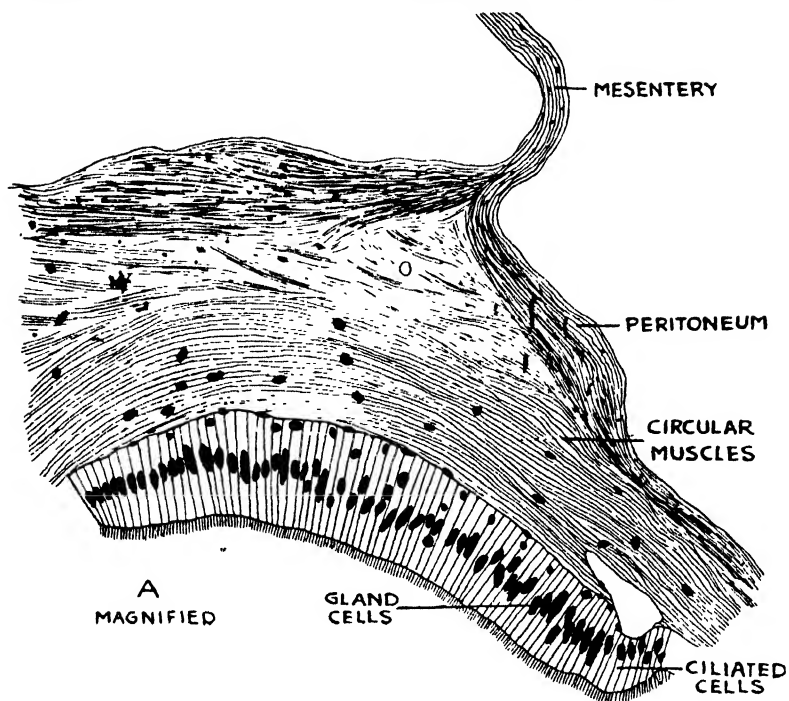


Fig. 3—A small part from Fig. 2 magnified $\times 240$.

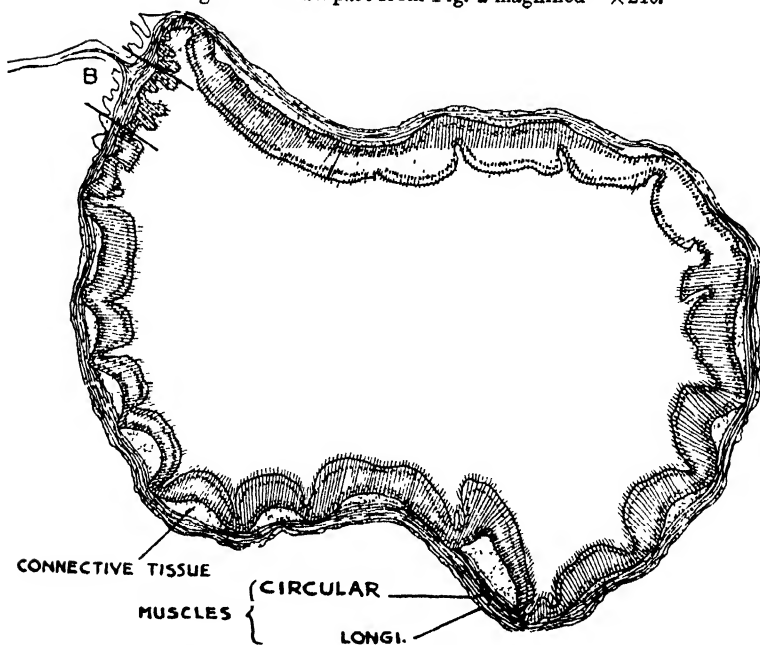


Fig. 4—Transverse section of the Oesophagus. $\times 50$.

peritoneal lining which is continued towards the body-wall in the form of numerous mesenteric strands. The latter consist of elastic fibres.

3. THE OESOPHAGUS. (Figs. 4 and 5). Immediately behind the pharynx, the oesophagus begins. Internally the triangular lumen of the pharynx gives place to an oval cavity, while the internal lining is raised into series of flat ridges separated by corresponding shallow grooves. Externally the radiating mesenteric bands of the pharynx give place to a pair of ventral mesenteries which bind the oesophagus to the ventral wall of the body. These ventral mesenteries are continued posteriorly right up to the junction of the gizzard with the crop.

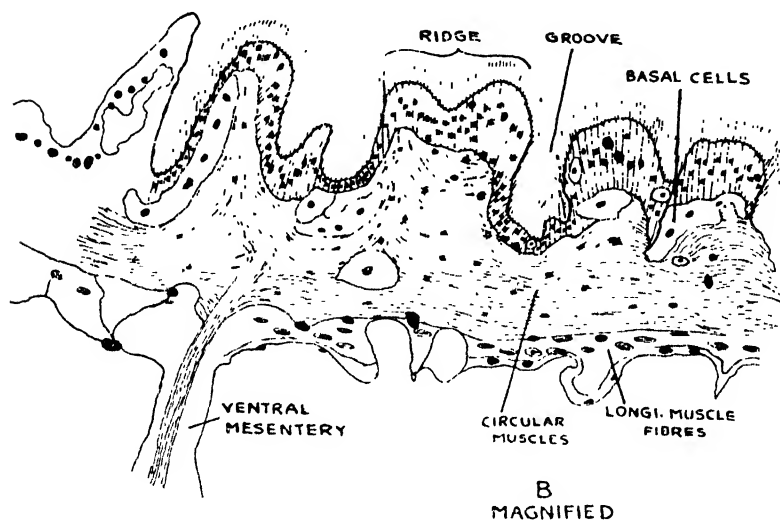


Fig. 5—Magnification of B in Fig. 4. $\times 240$

The oesophagus is the largest part of the canal in this section. Histologically the oesophagus presents several features which distinguish it from the pharynx. Each of the ridges is lined by tall cylindrical ciliated cells with many gland-cells, scattered among them; while the furrows are lined with cubical ciliated cells without any gland-cells (Fig. 5). The cilia arise from the distal thick walls of the columnar cells and are rather dense. The nuclei of these cells are located either near their distal ends or near their proximal ends so that there appear to be two rows of cells in the same epithelium (Fig. 5). This inner epithelium is surrounded on the outside by a thick layer of circular muscles which are in their turn covered over by a thin layer of longitudinal muscles. The peritoneal layer is, as usual, present on the exterior.

There is still another peculiar structure which is sometimes found at the base of the epithelial cells in the oesophagus. This structure consists of clear oval vacuoles with central nuclei. These vacuoles have been called by Spengel, "*Basal Cells*", while Jameson considers them as initial stages in the development of glandular cells. They are generally found near the attachment of a mesentery (Fig. 5).

4. THE GIZZARD. (Figs. 6 and 7). The oesophagus is followed by the gizzard, which is distinguished externally by its smooth glistening appearance.

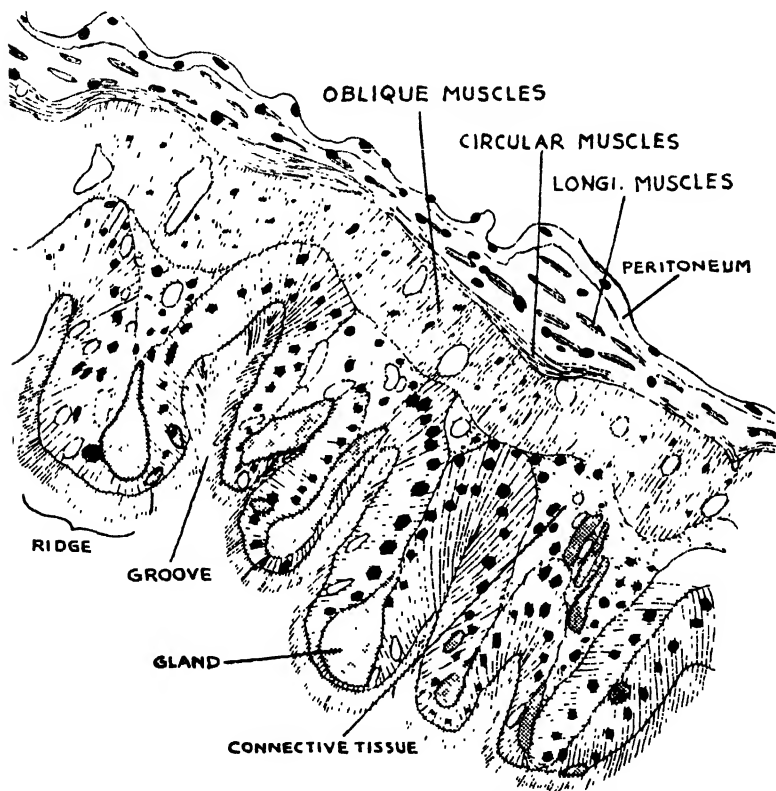


Fig. 6—A transverse section of the Gizzard. $\times 250$

Owing to the great development of the muscles on the innerside, the wall of the gizzard appears to be thick. Internally some of the ridges are taller and more prominent and the grooves proportionally deeper. The gizzard is kept in position by the pair of the ventral mesenteries which are continued from those of the oesophageal region as flat membranes or sheets on either side of the nerve cord.

Histologically, the wall of the gizzard presents almost all the features of the oesophagus but there are a few differences. The lining epithelium consists of tall cylindrical cells with a double row of prominent nuclei : one row lying near the distal ends of the cells, while the other about the middle (see the oesophagus above).

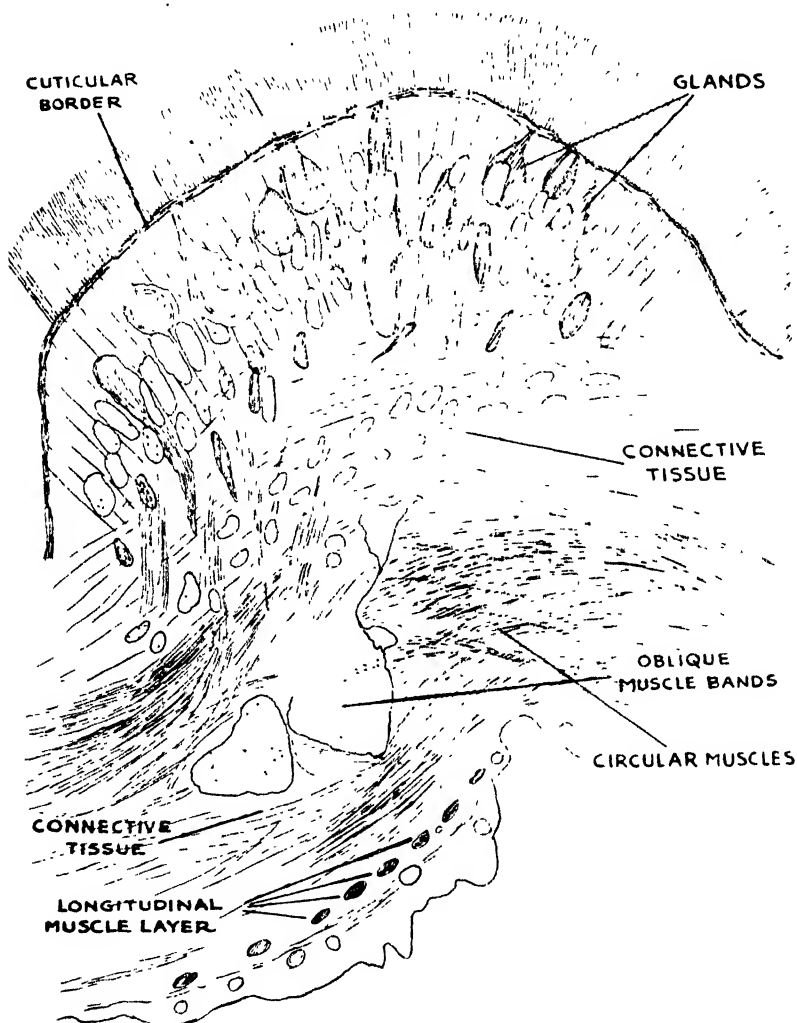


Fig. 7—A portion of the Gizzard magnified (oil immersion)

There are also many vacuoles which are found in between epithelial cells. These vacuoles may be representing glandular cells which have emptied their contents into the canal. The epithelial layer is surrounded by well-developed oblique muscles

which are covered externally by circular muscles. The longitudinal muscles are outermost and they do not form continuous but short separate bundles. Externally the gizzard is covered by a layer of the peritoneal epithelium.

A layer of fibrillar connective tissue similar to that of the oesophagus lies between the inner epithelium and the layer of muscle fibres.

Just before the gizzard opens into the crop, the characteristic ridges and furrows of the typical gizzard area disappear. This part forms a transitional area between the gizzard and the crop.

5. THE CROP. (Fig. 8 A and B). There are many important structural changes in the crop behind the gizzard. The ventral

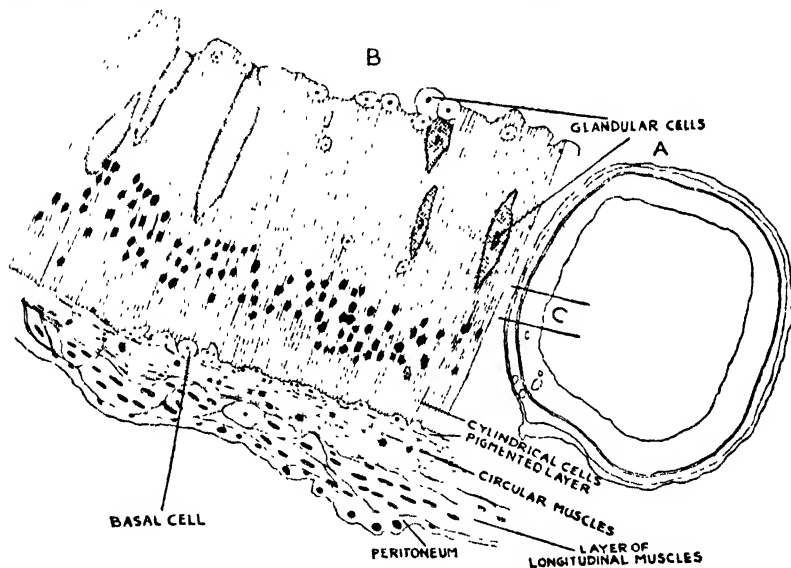


Fig. 8—A, Outline of a transverse section of the Crop. $\times 15$

B, Magnification of the portion C in A. $\times 150$

mesenteries disappear while the dorsal mesentery makes its first appearance and is found attached all along the dorsal surface of the crop. In between the double fold of this mesentery is found the dorsal blood vessel. This mesentery which runs towards the anterior end parallel with the dorsal blood vessel, attaches firmly the crop to the dorsal body-wall. The crop is surrounded on the dorsal side at its posterior end by an incomplete vascular ring formed by two transverse loop vessels opening into each other and into the dorsal vessel.

Externally the crop is not so smooth and glistening as the

gizzard. Internally there are also many important changes. The longitudinal ridges and grooves of the gizzard and the oesophagus disappear completely and in their place is found a more or less smooth lining of cells with an even surface. In some specimens longitudinal ridges and grooves are very faintly seen, while in others transverse ones are faintly marked. These facts seem to show that these faint ridges and grooves are due to contractions due to peristalsis at the time of fixing the animal.

Histologically the crop presents a very characteristic appearance. The epithelium consists of very tall cylindrical cells which are compactly arranged in tiers one above the other. This arrangement gives a stratified appearance to an inner epithelium. This appearance is probably due to the fact that these tall cylindrical cells are cut in transverse sections at different levels and they therefore, seem to show the stratified appearance (Fig. 8 B).

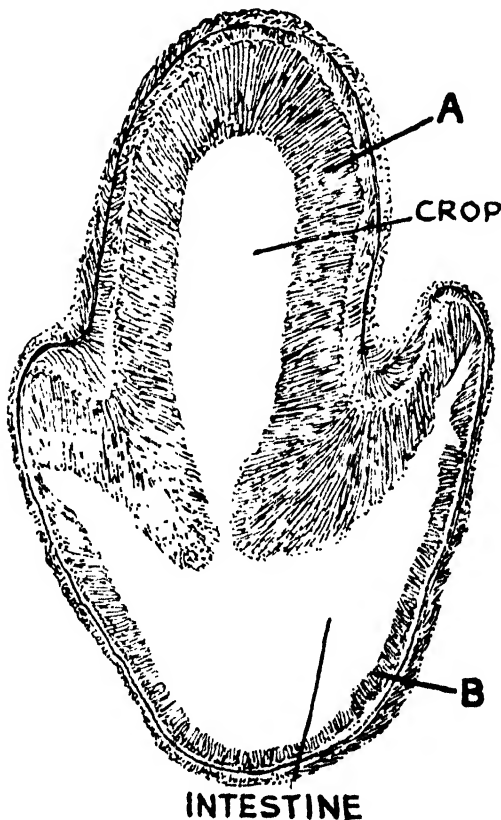


Fig. 9—A semi-diagrammatic figure of Sleeve Valve. $\times 36$

These cylindrical epithelial cells are not ciliated and this fact alone distinguishes the epithelium of the crop from that of the anterior regions of the alimentary canal. In *Thalassema bombayensis* the gland cells do not appear to be so well developed as they are in the case of *Thalassema neptuni* which have been described at great length by Jameson.

At places are found certain pigmented structures in a diffused state in between the layers of the epithelial cells and circular muscles. At other places clear cells each with the central nucleus, are seen at the base of the epithelium and are therefore known as basal cells.

The circular muscles are well developed and form a conspicuous and compact band round the inner epithelial lining. The longitudinal muscles are loosely arranged in bands across the vacuolar space which is bounded externally by the peritoneal membrane.

Towards the posterior end, the crop diminishes in size and passes into the intestine. At the junction of the crop with the intestine appears to be a valve which may be called a "Sleeve valve," because it forms a sleeve-like projection of the posterior extremity of

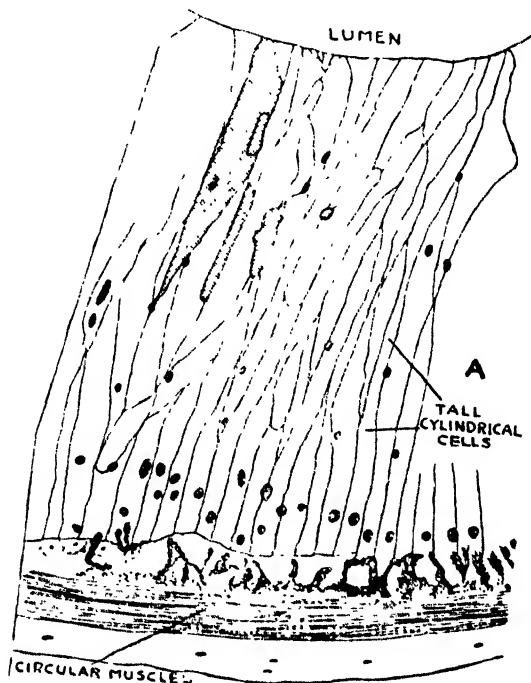


Fig. 10—A portion A in fig. 9 magnified. $\times 220$

the crop into the lumen of the anterior part of the intestine. This projected portion of the crop is of a double nature and its outer layer is continued on and becomes the epithelial lining of the intestine (Fig. 9).

Externally this valve is indicated by a conspicuous constriction to which Jameson has given the name of the "Preintestinal constriction". He does not, however, refer to this valve or any other valve in *Thalassema neptuni* at this place.

The structure of the valve can be easily understood from a longitudinal section of this region. The base of the valve is filled with muscles which are largely drawn from the layer of the circular muscles of the crop. This valve has two kinds of epithelia. One of the crop and the other of the intestine. The former consists of taller cells while the latter of short cylindrical cells (Figs. 10 and 11).

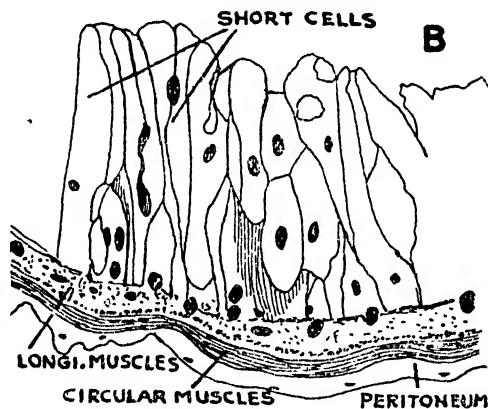


Fig. 11—A portion B in fig. 9 magnified. $\times 340$

II. THE MIDDLE SECTION OF THE ALIMENTARY CANAL

The parts of this section, as already mentioned above, are thrown into several loops of various lengths. These parts are characterised by the presence of a uniform epithelium consisting of more or less tall cylindrical cells loosely arranged, almost complete absence of the ciliated epithelium except in the beginning and the end of the Nebendarm, the presence of a continuous band of fibres of longitudinal muscles on the ventral side except in the regions of the Magendarm and Nebendarm, the presence of the dorsal mesentery and lastly by reversed arrangements of the layers of muscles surrounding the epithelium i. e. in the first section of the alimentary canal the circular muscles are

internal and are surrounded on the outside by the longitudinal muscles when present; while in this section the longitudinal muscles are internal and the circular are on the outside (Figs. 10 and 11).

In the place of the ventral muscular bands, Jameson has, however, described in *Thalassema Neptuni* a ciliated groove throughout this section. This ciliated groove in the regions of the Magendarm and Nebendarm is merged into the collateral stomach. In the present animal it seems to be entirely absent since the examination of many series of sections, several dissections and a few preparations of whole mounts have failed to reveal the presence of this ciliated groove. There are no cilia in any other regions except at the beginning and the end of the collateral stomach.

1. The Precollateral intestine (Zwischendarm) begins from the posterior end of the sleeve-valve, and forms approximately two loops. The dorsal mesentery which is a continuation of that of the crop, shows at its base a conspicuous intestinal sinus, since in a living animal there is a conspicuously coloured streak along the base of this mesentery. It may be, therefore, presumed that there is a series of sinuses at the base of the mesentery. It is in this region that faecal pellets are beginning to be formed and are, therefore, seen for the first time. The shorter of the two loops crosses the first sections of the canal in the region of the gizzard or the posterior part of the oesophagus, while the second which is longer, lies on the dorso-lateral side of the animal. Both the parts are attached all round to the body wall by narrow strips of suspensory ligaments in addition to the dorsal mesentery.

2. The collateral intestine (Mitteldarm) consists of two tubes of unequal dimensions situated dorso-ventrally. The dorsal tube (Magendarm) is bigger of the two with a wider lumen, while the ventral (Nebendarm) is very much smaller with a narrower lumen (Fig. 12).

The ventral tube (Nebendarm) is formed from the ventral part of the dorsal tube and its lumen is continued from that of the latter. At its beginning and its end it is lined with the columnar ciliated cells with prominent nuclei in the centre. The ciliated epithelium is not, however, found in the mid-portion of the Nebendarm (Fig. 13).

A series of transverse sections of the mid-portion of this part shows that the epithelia of the dorsal as well as of the ventral tube consists of tall cylindrical cells with nuclei irregularly scattered, though many of them are found located nearer the base. The epithelia are surrounded by well developed fibres of longitudinal muscles which are covered over their external sides by a layer of

weakly developed circular muscles. The peritoneal layer is found on the outside of these muscles. There are also basal and gland cells (Fig. 12).

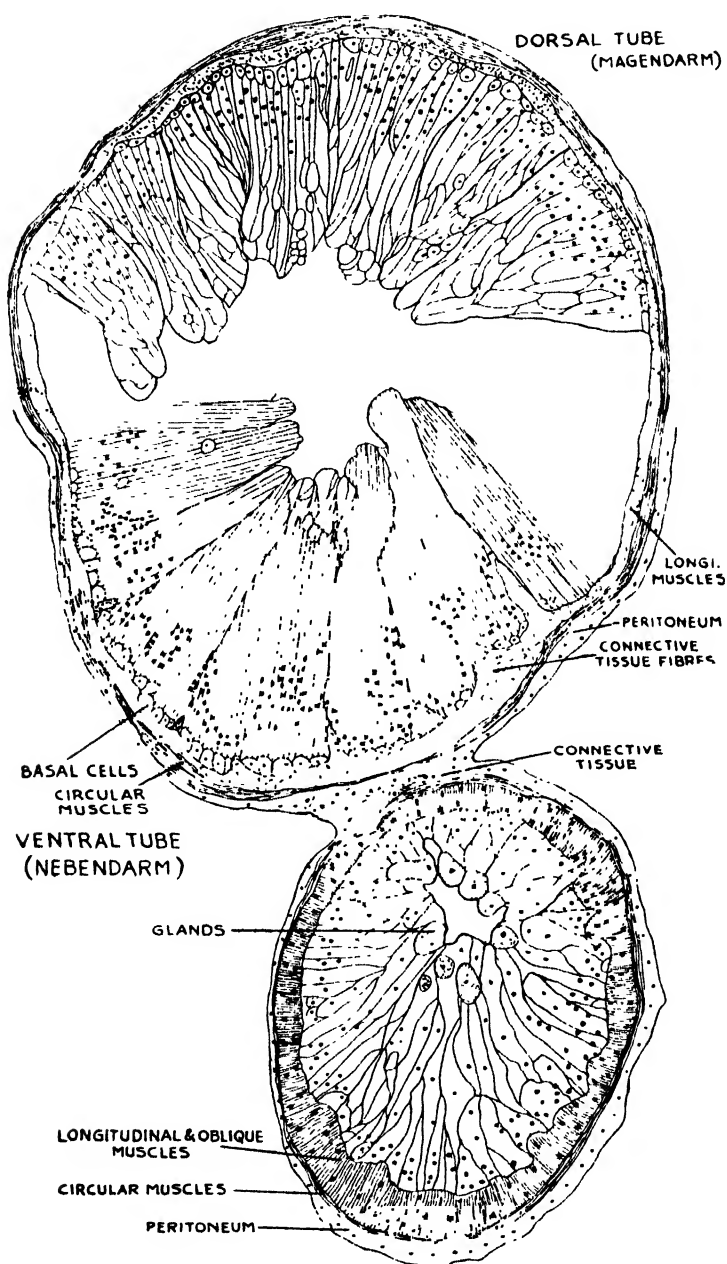


Fig. 12—A transverse section of the Mitteldarm. $\times 96$

There are, however, certain differences in the histological structures of these two tubes. In the dorsal tube the basal cells are very well developed at the base of the epithelial layer, while they are entirely absent in the ventral tube. Secondly the longitudinal muscles in the ventral tube are much more strongly developed than in the dorsal tube. Thirdly there are prominent glandular cells in the neighbourhood of the lumen of the ventral tube while they are not so prominent in the dorsal tube. And lastly there is a great development of the connective tissue in the dorsal tube so as to give an additional strength to the longitudinal muscles of the latter in order to drive out the faecal matter and sand particles. The collateral intestine undergoes a great deal of looping. Its extent can be easily understood from the figure (Fig. 1).

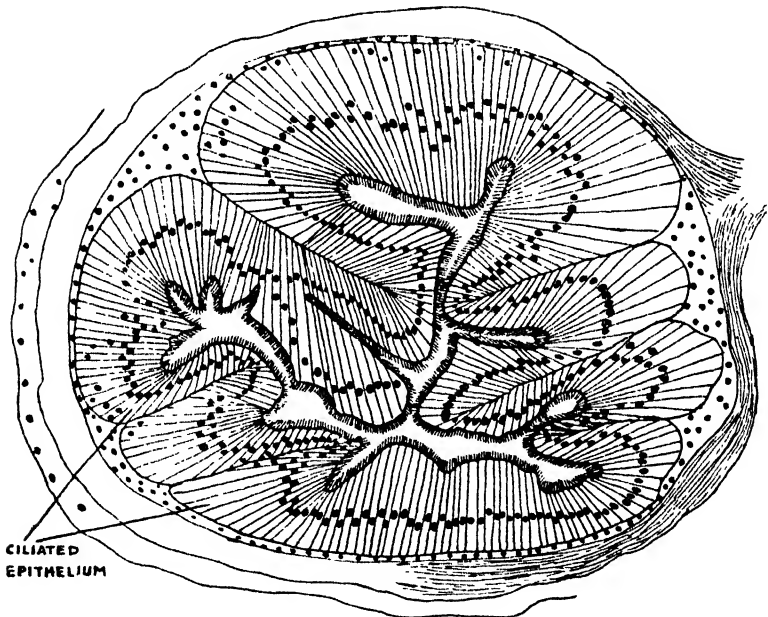


Fig. 13—Transverse section of the posterior end of the Nebendarm showing ciliated epithelial cells. $\times 210$

Function of the collateral stomach. The dorsal tube is generally filled with faecal pellets as well as sand particles. A current of water must therefore be obstructed while passing through it. Diverted through the ventral tube by the movement of the cilia found at its mouth, its continuous flow would be maintained by the movement of the cilia at the other end of the tube and also by the well developed muscles. This continuous current bringing in fresh water may be useful to the animal for respiratory purposes.

III. POST-COLLATERAL INTESTINE (HINTERDARM)

This structure begins from the place where the Nebendarm opens posteriorly into the alimentary canal and ends near about the region where the anal vesicles empty into it. According to Jameson, there is a little pouch or caecum at the end of this part of the alimentary canal which marks the beginning of the rectum in *Thalassema neptuni*. This caecum seems, however, to be absent in the present animal.

This part of the intestine can be divided into two portions not by any differences in the internal or external structures but by the fact that its proximal portion is looped while the distal is almost straight.

(1) The proximal portion which forms the last loop is always full of faecal pellets and is, therefore extremely distended. It is difficult on that account to make out its normal epithelial structures. The epithelial cells are either distorted when this region is empty or more or less of a cubical shape when it is stretched out. The arrangement of the muscles is rather perplexing. In some sections the layer of the longitudinal muscles seems to be surrounded by the circular muscles while in others of the same series the reverse is the case. As there are no intrinsic differences between the longitudinal and the circular muscles and the parts cut into sections are so mobile and elastic while living that it is possible that the sections of the same series may be cut along different planes and hence different pictures are to be seen in the same series.

(2) The distal portion forms the colon. *Thalassema bombayensis* seems to have no caecum as already mentioned above. In this region, however, the ventral (neural) vessel is attached to the ventral portion of the colon to which is generally found attached the genital stolon.

The distal part of the colon extends from the attachment of the genital stolon to the opening of the anal vesicles into the digestive canal. The epithelium is very irregular and consists of columnar or thread like cells, the free ends of which broaden out and merge into each other to form a pavement epithelium.

IV. END PARTS OF THE ALIMENTARY CANAL ARE:—

1. RECTUM OR CLOACA. (Figs. 14 and 15). The rectum or the cloaca is the last portion of the alimentary canal. In the whole of this region there are prominent longitudinal folds and grooves lining the lumen. The epithelium of these folds and grooves consists of low columnar or cubical cells which are

ciliated. Gland cells are also found scattered in the epithelium of the ridges. On the outside of the epithelium there are prominent bands of the circular muscles. Between the latter and the epithelium there is a connective tissue in which are found many gland cells, with very prominent nuclei. This glandular tissue has already been described by Rietsch, who has termed it as the peri-anal glandular organ. This tissue increases in extent towards the posterior end.

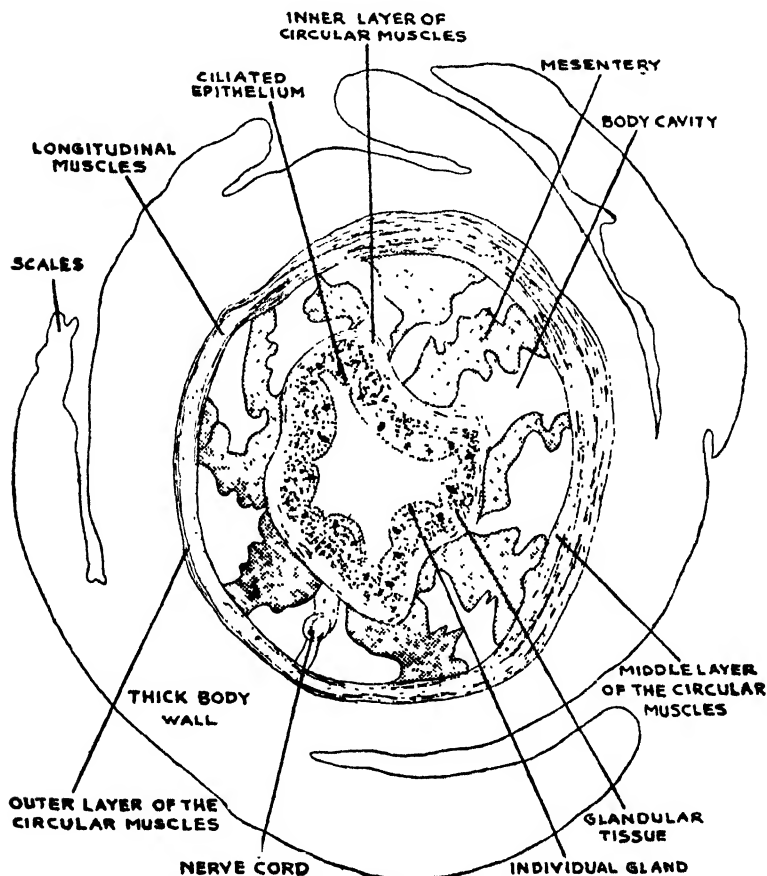


Fig. 14—T. S. of the posterior part of the body, passing through the rectum and showing the three layers of muscles. $\times 7$

The arrangement of the muscles varies considerably as one proceeds towards the posterior end of the animal. At the place where the anal vesicles open into the canal, there are three layers of circular muscles; the innermost lying on the top of the connective and glandular tissue, the middle layer lying outside the radial

mesenteries and surrounding the body cavity and lastly the outermost layer along the inner side of the body-wall below the peritoneum. The layer of longitudinal muscles which are very weakly developed is found between the middle and the outermost layers of the circular muscles (Fig. 14).

Towards the posterior end of the rectum certain important changes seem to occur in the arrangement of these muscles and the mesenteries. The latter have already disappeared or are fast disappearing while the innermost and the middle layers of the circular muscles are merging into each other to form one layer. Similarly the layer of longitudinal muscles is also disappearing. Ultimately a very big band of the circular muscles is thus formed by coalescence of all the three different layers with one another which will, later on, become the sphincter muscle (Fig. 15).

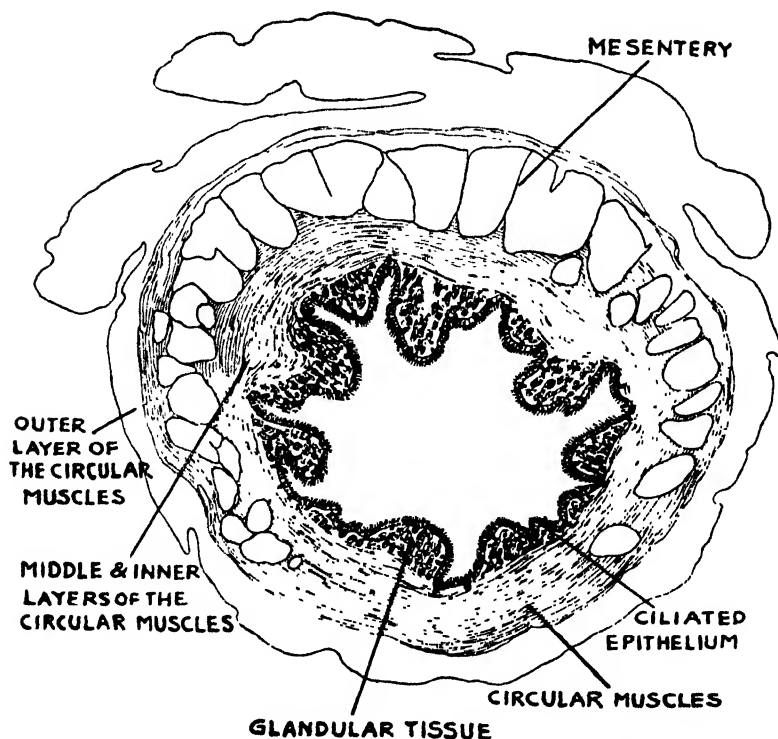


Fig. 15—Transverse section of the posterior part of the body passing through the Rectum and showing the three layers fusing into one. $\times 7$

The rectal portion should be termed the cloaca, since the anal vesicles which are the excretory organs of the animal open into

the last portion of the alimentary canal and the excretory and the rectal opening to the outside is common.

2. ANUS OR THE CLOACAL APERTURE. The anus is situated at the extreme posterior end of the animal. It has been noticed that water is continually forced out through the anus in a living animal. It is doubtful whether any water is taken in through the same aperture. The current of fresh water which enters the mouth, and is maintained by the ciliary movements of the cilia of the cells of the Nebendarm passes out at the other end through the anus so that a continuous current is kept up through the whole of the alimentary canal.

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A NEW GENUS AND SPECIES OF ZORAPTERA

BY

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(Department of Biology, Wilson College)

(*With 2 Text-figures*)

MENONIA, GENUS NOV.

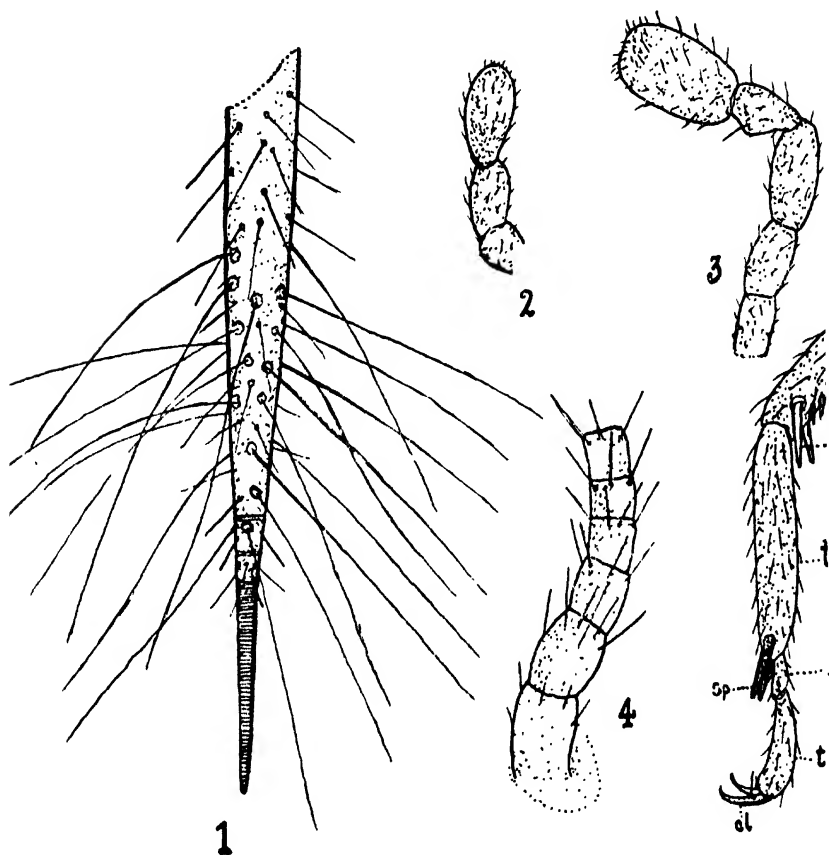
Apterous. Head and prothorax well developed. Antennae of several segments; not moniliform; segments short and cylindrical. Maxillary palpi 5-jointed. Labial palpi 3-jointed. Tarsi 3-jointed. Cerci long, tapering towards the apex; 4-jointed.

MENONIA COCHINENSIS, SPECIES NOV.

General colour yellowish-brown. Head is bent at right angles to the main axis of the body and bears a few scattered hairs. Clypeus slightly convex, resembling those of Psocids. Antennae (fig. I.4.) are broken in the specimen and the stump consists of only six segments. The lengths of these segments are in the ratio 4 : 4 : $3\frac{1}{2}$: $3\frac{1}{2}$: $2\frac{1}{2}$: 3. Maxillary palpi (fig. I.3.) 5-jointed; last segment broadly oblong, about two-thirds as broad as long. Ratio of the segments of the maxillary palpi is 3 : $3\frac{1}{2}$: 5 : $3\frac{1}{2}$: 7. Labial palpi (fig. I.2.) 3-jointed; pale yellowish-brown. Antennae and palpi with scattered hairs. Hairs slender and more numerous at the apex of the last segment of the palpus. Eyes, small, situated on the sides of the head, at the bases of the antennae. Ocelli absent.

Prothorax well developed; colour, a tint of light chocolate brown. Comparative lengths of thoracic tergites are 2 : 1 : 1. The notal sclerites not secondarily divided by sutures. Wings entirely wanting. Legs pale yellowish-brown. Hind femora broad and well developed. Tarsi 3-jointed, last segment bearing a pair of claws. Claws rather straight with pointed and curved apices. The pro-thoracic tibiae carry a spur towards their apices. The first segment of the pro-thoracic tarsi bears about nine strong spinous hairs arranged in a line on elevated chitinous outgrowths which resemble the "Ctenidia" of the meta-thoracic tarsi of certain Psocids. The meta-thoracic tibiae carry two conspicuous spines towards their apices and three short spines proximal to these arranged as shown in the figure (fig. I.5). The first tarsal segments of the meta-thoracic legs bear a pair of stout spurs at their apices. Ratio of the hind tarsal segments is 6 : 1 : 3.

Abdomen yellowish-brown. There are ten distinct tergites. The last segment bears a pair of cerci. Cerci (fig. I.1) composed of four segments. The first cercal segments are very long and broad at the base; second and third segments very short and the last



Text fig. I—*Menonia cochinensis*. Sp. nov. ($\times 140$ approx.).

1 cercus; 2 labial palpus; 3 maxillary palpus; 4 antenna; 5 posterior part of the tibia, tarsal segments and claws of the meta-thoracic leg.

t, tibia; t_1 - t_3 , tarsal segments; cl, claws; sp, spinea.

segments about half as long as the first. The first three cercal segments carry both macrotrichia and sensory hairs. The last segment is narrow and annulated and devoid of hairs.

Measurements :—

Length of body (excluding cerci) 1·27 mm.

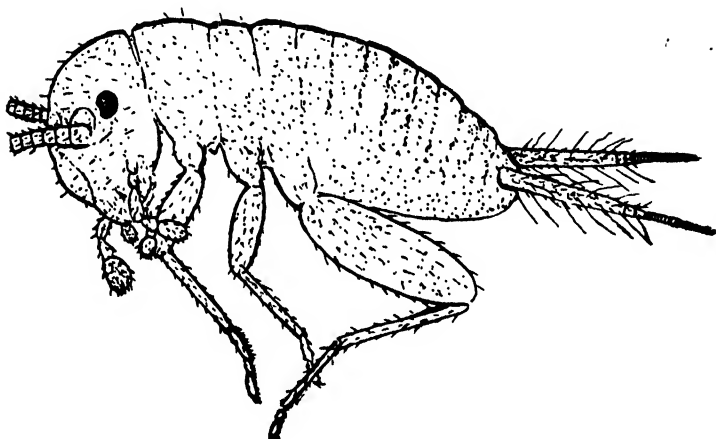
Length of cerci 0·6 mm.

Locality :—

South India. (Tripunithura—Cochin State).

Date of collection :—

15-4-1935. One specimen (♂) collected from dry foliage on the ground.



Text. fig. II—*Menonia cochinensis*, sp. nov. Lateral view of the whole animal. (Legs of one side not shown). (× 50 approx.)

The general characters, three-jointed labial palpi and the cerci, place this insect in the order Zoraptera. But it differs from species of *Zorotypus* in the possession of three-jointed tarsi and absence of moniliform antennae. Therefore I have no hesitation in creating a new genus for this insect.

I have great pleasure in naming this insect after my colleague and student M.G.R. Menon who has collected it.

NOTES ON OLIGOTOMA COLLECTED FROM BOMBAY
AND COCHIN TOGETHER WITH THE
DESCRIPTION OF A NEW SPECIES

(*With three plates.*)

BY

RAMDAS MENON & C. J. GEORGE

(Department of Biology, Wilson College)

Introduction

Species of *Oligotoma* recorded from India are few. *O.saundersi*, the first to be recorded, was described as early as 1837 by Westwood. This was followed by the descriptions of *O.latreillei* (Rambur, 1842); *O.michaeli* McLachlan, 1878; *O.ceylonica* Enderlein, 1912; *O.greeniana* Enderlein, 1912; *O.ceylonica* Enderl. var. *variegata* Mukerji, 1935 and *O.minuta* Mukerji 1935.

The Oligotomids so far collected from Bombay and Cochin consist of *O.saundersi*, *O.latreillei*, *O.ceylonica* var. *variegata*, and a species new to science which is described below as *O.asymmetrica*. Though there are a few minor differences we consider our first species is *O.saundersi* and give below a detailed description of its posterior-most segment and appendages which are of great taxonomic value. Similarly for *O.latreillei*, we take this opportunity to give a full description of the terminal segment. There are in our collection as many as eighteen specimens of *O.ceylonica* var. *variegata* and we have been able to note the extent of variation of the terminal segment of this variety.

A table of comparative measurements of the species concerned is appended.

Habits

During the monsoon months in Bombay, extending from the middle of June to the middle of September, one often comes across a number of Oligotomid webs on old walls overgrown with moss. They are easily mistaken for those of spiders, but on a closer examination each web will be found to be inhabited by a single Oligotomid. Sometimes, along with a mother, a number of young ones also may be seen under the web. During the hotter months of the year the Oligotomids are never seen inhabiting such exposed places; instead they are found to recede into crevices, under barks of trees and such other humid and shady places. This probably shows their preference to a moist atmosphere.

1. OLIGOTOMA SAUNDERSI Westwood, 1837.

(Plate I, figs. 1a & 1b).

The last abdominal segment of this species presents the following features. The tenth tergum is divided into three unequal plates. Of these the median one (m.p.) is comparatively small and its posterior margin is bluntly rounded. The right tergal plate (r.t.) is broad at the base and is produced posteriorly into a finger-shaped process (r.p.). This process is a little bulged at about the middle and is directed towards the left cercus. Its acuminate apex carries on the right a short lateral spinous process. The left tergal plate (l.t.) is circular basally and arched dorsally and it bears a bi-lobed appendage posteriorly (l.p.). The left lobe of this appendage is short and spiniform and is curved towards the inner side. This lobe is not present in some specimens. The right lobe of the left tergal process is produced into two curved and pointed teeth. The last sternite (the fused ninth and tenth sternites—s.t.) is almost triangular in shape and is directed towards the left cercus. This species is said to bear on the apex of the last sternite a pair of hooks, disposed right and left. In our specimens these hooks are however absent.

The cerci are two-jointed. The left cercus is attached to a basal piece (the vestigial eleventh segment) (l. c. b. p.) which is narrow and elongated. This is bi-lobed in some specimens; the right lobe is bluntly rounded and the left one is produced into a spur-like process which is either free or attached to the basal segment of the left cercus. This process is unrepresented in some specimens. The basal segment of the left cercus (l.c.₁) is club-shaped and its inner margin is fused along the whole length of the basal piece. The basal segment of the right cercus (r.c.₁) is somewhat conical in shape and is slightly shorter than the basal segment of the left cercus. The terminal cercal segments (l.c.₂ and r.c.₂) are sub-equal and elongate-oval in shape.

Locality and date of collection :—Mahim, (Bombay City), 8. vii. 1934, 1 (♂); Thana, (Salsette), 15. vii. 1934, 1 (♂); Santa Cruz, (Salsette), 24. xi. 1935, 3 (♂); Ernakulam, (Cochin State), 30. xii. 1935, 1 (♂). All at light. Collected by Ramdas Menon.

2. OLIGOTOMA LATREILLEI Rambur, 1842.

(Plate I, figs. 2a & 2b.).

The tenth tergum presents the following features. It is divided into three plates. The middle plate (m.p.) is almost

triangular in shape and rounded at the apex. The right tergal plate (r.t.) is broad at the base and is narrowed posteriorly into a finger-shaped process (r.p.). This process is slightly swollen at the tip and is directed towards the left cercus. The left tergal plate (l.t.) is semicircular at the base and is posteriorly produced into a narrow finger-shaped process (l.p.). This process is rather pointed and extends to about two-thirds the length of the right tergal process and ends between the two lobes of the last sternite (s.t.). The anterior half of this sternal plate is comparatively broad and its posterior half is almost boat-shaped. Its apex is bi-lobed and the lobes are separated by a concave, strongly chitinised posterior margin. The right lobe of this is stout, turned dorsad and bears at the apex a cup-shaped depression. The left lobe is short and bluntly pointed.

The cerci are two-jointed and somewhat asymmetrical. The left cercus is attached to a basal piece (l. c. b. p.) which is posteriorly elongated. The basal segment of the left cercus (l.c.₁) is club-shaped and attached along the whole length of the outer margin of the basal piece. The basal segment of the right cercus (r.c.₁) is broader at the base than at the apex and is somewhat shorter than the basal segment of the left cercus. The terminal cercal segments (l. c.₂ & r. c.₂) are sub-equal and elongate-oval.

Locality and date of collection :—Santa Cruz, (Salsette), 25. viii. 1935, 3 (♂), 26. viii. 1935, 1 (♂), and 24. xi. 1935, 1 (♂); Ernakulam, (Cochin State), 30. xii. 1935, 8 (♂). All at light. Collected by Ramdas Menon.

3. OLIGOTOMA CEYLONICA Enderl. var VARIEGATA Mukerji 1935.* (Plate II).

In the general organisation of the terminal segment and appendages all specimens of this species in our collection agree with *O.ceylonica* var. *variegata*; but in certain features some differences are to be noticed.

The tip of the right tergal process usually ends in two protuberances separated by a concavity as described by Mukerji; but the sizes of these protuberances are found to vary to a greater extent than shown by him. In some specimens this process ends in a bluntly rounded tip. The tip of the left process may reach or protrude beyond the limit of the last sternite (s.t., fig. 2a), but in Mukerji's specimens it appears in every case to extend beyond

*Mukerji in Rec. Ind. Museum. Vol. XXXVII Part I, 1935, pp. 4-7, text fig. 2.

the sternite. The posterior margin of the last sternite is rounded in Mukerji's specimens; but in our specimens it is either rounded or bluntly acute as shown in the figure.

The cavity on the basal segment of the left cercus in our specimens exhibits a wider range of variation than shown by Mukerji (Fig. 1. A-F). In some specimens the posterior outer margin of this cavity is even produced into a stout blunt spine.

The specimens in our collection vary in length, measuring from 5 m.m. to 7 m.m., excluding cerci. Mukerji's specimens appear to be smaller in size, measuring only 5.5 mm.

In this connection we also wish to mention that Needham's figure* of *E. michaeli* resembles some of our specimens which show the extremely well developed cavity on the left cercus. Therefore we are tempted to conclude that he might have had before him a specimen of *Oligotoma ceylonica* var. *variegata*.

Locality and date of collection:— Santa Cruz, (Salsette), 10-vi-1935, 1 (♂), at light; 16-vi-1935, 2 (♂), under web on old moss-grown walls; 17-xi-1935, 1 (♂), at light; 23-xi-1935, 1 (♂), at light; 25-xi-1935, 1 (♂), at light; Ernakulam, (Cochin State), 28-ix-1935, 2 (♂), at light; 30-xii-1935, 10 (♂), at light. Collected by Ramdas Menon.

4. OLIGOTOMA ASYMMETRICA, Spec. nov. (Plate III).

General colour brownish-black. Head, antennae and prothorax almost black; Meso- and meta-thorax, legs and abdomen somewhat lighter; wings greyish-black; veins almost brownish black; "pseudo-radial lines" brownish; hyaline bands narrow and well marked out.

Head almost roundish. Eyes reniform, slightly bulging out laterally, about two-thirds visible from above; deep black. Antennae (fig. 3) 23-jointed; segments cylindrical and densely pubescent. First six antennal segments are in the ratio 12 : 6 : 10 : 11 : 13 : 13. Maxillary palpi (fig. 2) 5-jointed; segments in the ratio 5 : 5 : 6 : 9 : 12.

Thoracic segments well-developed. Pro-thorax with a deep transverse and shallow longitudinal sulcus; rectangular; somewhat longer than broad. Meso- and meta-thorax almost of the same type of construction. Each of these bears on the dorsal side a shallow depression extending over the anterior half of the prescutum. The meso-notum bears a posterior semicircular scutellar area.

*Needham in Rec. Ind. Museum, Vol. III 1909, Plate xx.

Wings (fig. 4) are long and narrow as in other Embiids. They reach to about the tip of the last abdominal tergite. The following veins are distinctly discernible; the basal part of sc., r_{1+2} , r_{2+3+4} , base of r_{4+5} , cu and a. and the radial cross-veins. All the other veins are very indistinctly demarcated. The radial cross-veins are about four in number in both wings. Macro- and micro-trichia are present on the margins, veins and membrane.

The abdomen is ten segmented. The first abdominal segment is fused with the meta-thorax. Segments 2-8 are sub-equal in size. Ninth segment is slightly compressed. The tenth tergum (Fig. 1) is divided into three plates. The middle plate (m.p.), is triangular in shape and rounded at the apex. The right tergal plate (r.t.) is broad at the base and is posteriorly produced into a finger-shaped process (r.p.). This process slowly narrows down into a bi-fid apex, as shown in the figure. The left plate (l.t.) is also broad at the base and its posterior margin is produced into two lobes. Of these the inner one (i.l.t.) is bluntly rounded; the outer one is produced into a long finger-shaped process (o.l.t.). The last abdominal sternite is almost triangular in shape; its apex is slightly swollen and bent towards the dorsal side and in the concavity formed by this bend rests the tip of the left tergal process.

The cerci (Fig. 1) are two-jointed and exhibit a more pronounced asymmetry. The left cercus is attached to a basal piece (l.c.b.p.). This piece is short and cylindrical and resembles that of *Oceylonica* var. *variegata*. The basal segment of the left cercus is irregularly flattened out and twisted in a peculiar way as shown in the figure (l.c.₁). The basal segment of the right cercus (r.c.₁) is almost cylindrical in shape. The terminal cercal segments sub-equal and elongate oval.

Locality and date of collection:—Santa Cruz, (Salsette), 14-viii-1935, 1 (♂), at light. Collected by Ramdas Menon.

Acknowledgment

We take this opportunity to express our gratitude to the authorities of the Royal Institute of Science, Bombay, and the Imperial Institute of Agricultural Research, Pusa, for the loan of the necessary books from their libraries.

Literature

A list of literature on the Order is given by Okajima, (Jour. Coll. Agr., Imp. Univers., Tokyo, Vol. VII, 1919-1926) and Mukerji (Rec. Ind. Mus. Vol. XXIX. P. IV, 1927) and we deem it unnecessary to repeat it here.

Explanation of the Plates

- Plate I. Fig. 1a. *Oligotoma saundersi* Westwood. Terminal segment and appendages. Dorsal view. ($\times 50$ approx.).
- Fig. 1b. *Oligotoma saundersi* Westwood. Last sternite and the parts associated with it. Ventral view. ($\times 50$ approx.).
- Fig. 2a. *Oligotoma latreillei* (Rambur). Terminal segment and appendages. Dorsal view. ($\times 50$ approx.).
- Fig. 2b. *Oligotoma latreillei* (Rambur). Last sternite. Ventral view. ($\times 85$ approx.).
- Plate II. Fig. 1.A-F. *Oligotoma ceylonica* var. *variegata* Mukerji. The basal segments of the left cercus showing the extent of variation of the concavity. A-C. Cochin forms. D-F. Bombay forms. ($\times 105$ approx.).
- Fig. 2a. *Oligotoma ceylonica* var. *variegata* Mukerji. The terminal segment and appendages. Dorsal view ($\times 85$ approx.).
- Fig. 2b. *Oligotoma ceylonica* var. *variegata* Mukerji. The last sternite and the parts associated with it. Ventral view. ($\times 85$ approx.).
- Fig. 1. *Oligotoma asymmetrica*, sp. nov. Terminal segment and appendages, Dorsal view, ($\times 50$ approx.).
- Fig. 2. *Oligotoma asymmetrica*, sp. nov. Maxillary palp. ($\times 50$ approx.).
- Fig. 3. *Oligotoma asymmetrica*, sp. nov. Antenna. (First 8 segments.) ($\times 35$ approx.).
- Fig. 4. *Oligotoma asymmetrica*, sp. nov. Right pair of wings. ($\times 18$ approx.).

Lettering

- i.l.t. = inner lobe of left tergite.
 l.c.₁ = basal segment of left cercus.
 l.c.₂ = terminal segment of left cercus.
 l.c.b.p. = basal piece of left cercus.
 l.p. = process of left tergite.
 l.t. = left tergal plate.
 m.p. = median tergal plate.
 o.l.t. = outer lobe of left tergite.
 r.c.₁ = basal segment of right cercus.
 r.c.₂ = terminal segment of right cercus.
 r.p. = process of right tergite.
 r.t. = right tergal plate.
 st. = last sternite.

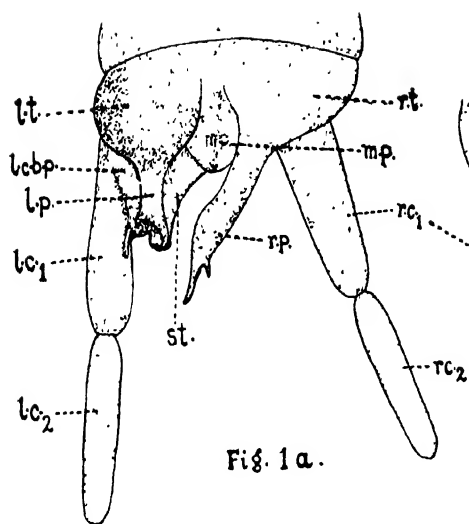


Fig. 1a.

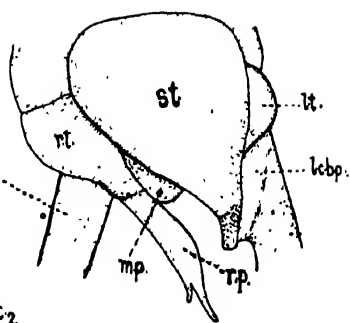


Fig. 1b.

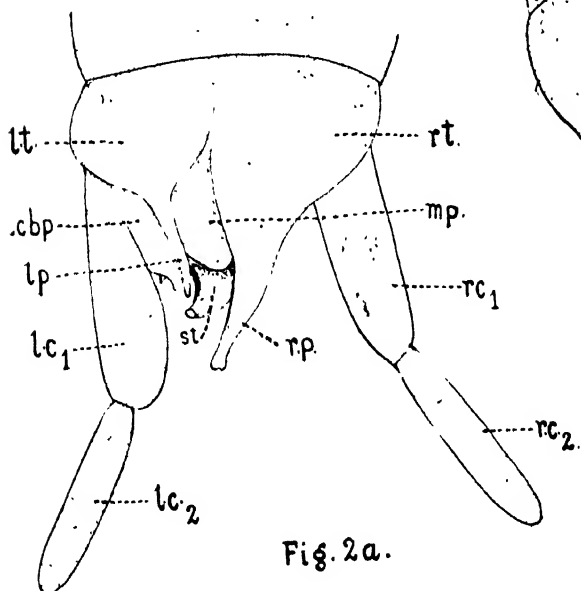


Fig. 2a.

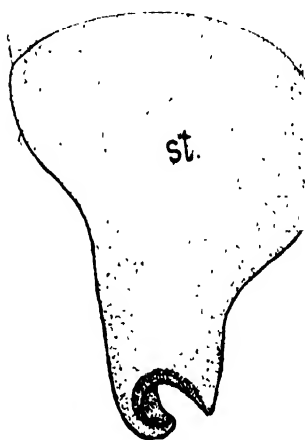


Fig. 2b.

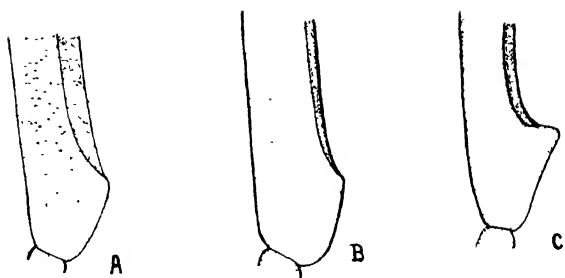


Fig. 1.

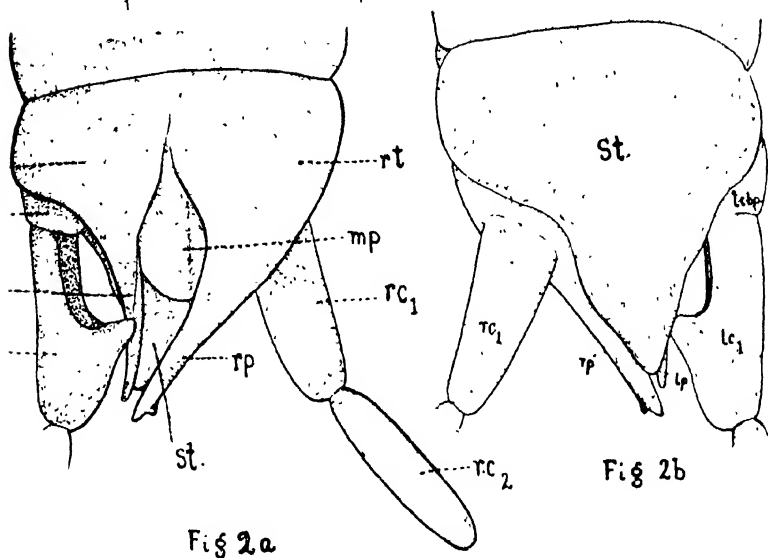
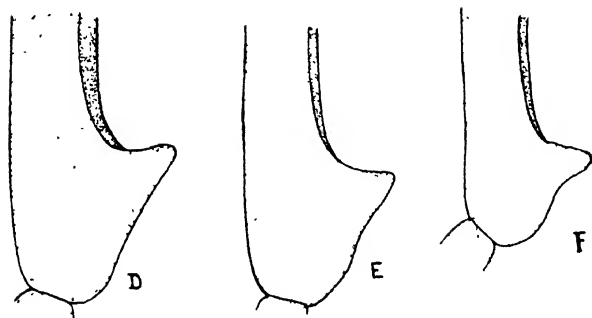


Fig 2a

Fig 2b

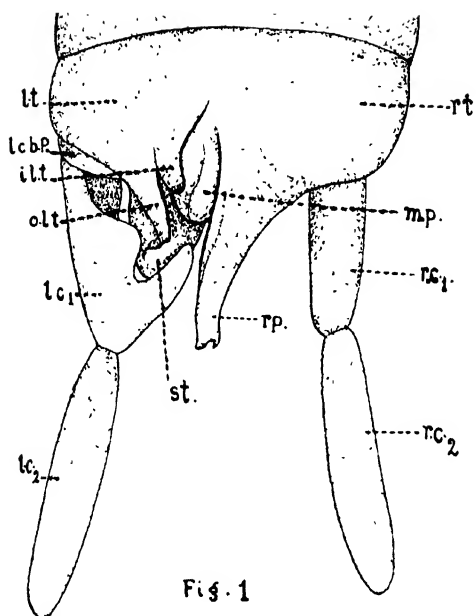


Fig. 1



Fig. 2.



Fig 3

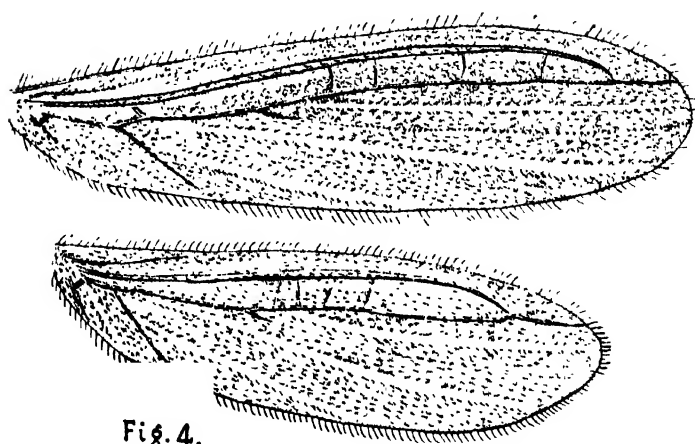


Fig. 4.

Appendix

Comparative measurements of the species of *Oligotoma* collected from Bombay and Cochin :—

	<i>O.saundersi.</i>	<i>O.latreillei.</i>	<i>O.ceylonica</i> var. <i>variegata.</i>	<i>O.asymmetrica.</i>
Length of body.	7·7—8mm.	8·6mm.	6—7mm.	9·3mm.
Length of head.	1·14mm.	1·23mm.	·97—1·14mm.	1·54mm.
Breadth of head.	·97mm	·91mm.	69—1·03mm.	1·2mm.
No. of antennal joints.	18	19	16	23
Length of Prothorax.	·51mm.	·63mm.	·46—·51mm.	·85mm.
Breadth of Prothorax.	·54mm.	·57mm.	·51—·57mm.	·74mm.
Length of mesothorax.	1·08mm.	1·14mm.	·97—1·03mm.	1·4mm.
Breadth of mesothorax.	·97mm.	1·09mm.	·86mm.	1·3mm.
Length of metathorax (including 1st. abd. segment)	1·08mm.	1·03mm.	·91—1·03mm	1·3mm.
Breadth of metathorax	·85mm.	1·03mm.	·74—·86mm.	·98mm.
Length of forewing.	5·8—6mm.	5·7mm.	4·6—5·03mm.	5·5mm.
Breadth of forewing.	4·9mm.	4·9mm.	3·7—4·17mm.	4·5mm.

PROBOSCIS OF THALASSEMA BOMBAYENSIS

(PRASHAD AND AWATI)

(*With 8 text-figures*)

BY

P. R. AWATI

(Department of Zoology, Royal Institute of Science, Bombay)

The proboscis is a characteristic structure found amongst all the Echiuroids. It is a prolongation of the dorsal lip or the preoral part of the larva as Lacaze-Duthier and Spengel (3) have made out. This dorsal lip projects more or less over the mouth as in other annelida. It is a fleshy and at the same time highly contractile organ which when fully extended, assumes an almost ribbon-like form in some and spade-like in others. In the normal condition, however, it is more or less cylindrical, the dorsal surface being fleshy and convex in outline, while the ventral surface is almost flat, its margins being rolled in. This flat surface bears longitudinal folds which form channels on its surface. The margins of the proboscis are wavy and crenulated and a little rolled while the tip is subtruncate and assumes roughly a semi-circular shape. Its basal portion is very much narrower than its mid region and the margins in this region (basal) are stiff and strongly incurved. They form the sides of a sort of a funnel through which the water flows into the mouth which is situated at the base of that funnel.

The sides of the proboscis can be curved in to such an extent so as to form almost a narrow and deep gutter (channel), its bottom being formed by its ventral median surface.

The proboscis is a more or less stoutly built structure having a spongy mass of a connective tissue containing muscles, circum-pharyngeal commissures of the nerve cord, dorsal and marginal blood vessels and lastly narrow coelomic marginal sinuses enclosing the latter (Fig. 1).

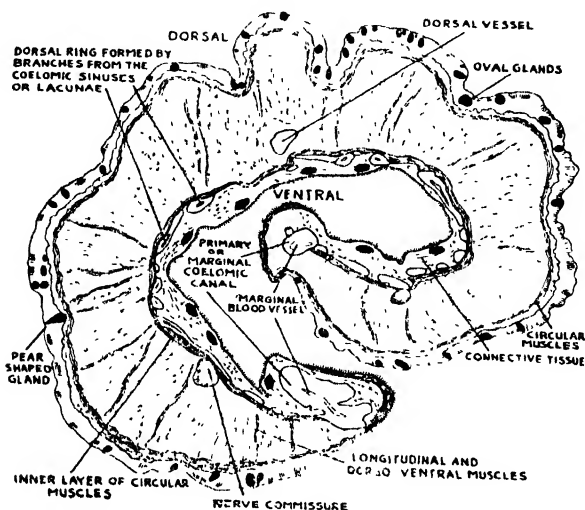
The tissues forming the proboscis are :—(Figs. 1, 2 and 3).

(1) The Cuticle. It covers the entire dorsal epidermal layer and is almost similar to that of the trunk. It is absent on the ventral surface. It is rather a thick non-cellular structure (Fig. 2).

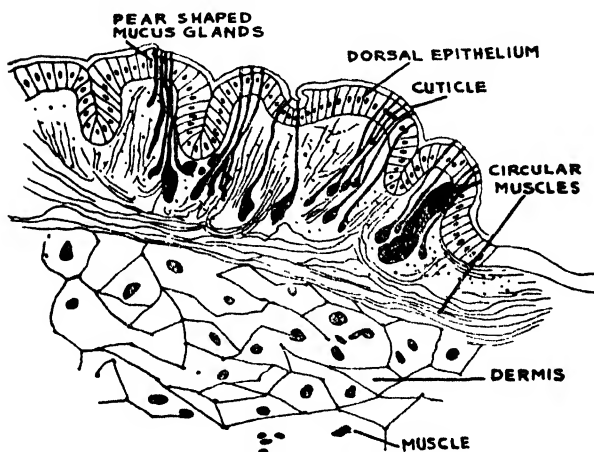
(2) The Epidermis. The epidermal linings of the dorsal and the ventral surfaces are different. The dorsal epithelium, like that of the trunk consists of cylindrical and non-ciliated cells amongst

which are found embedded ducts of gland cells as well as external parts of receptors (Fig. 2).

The ventral epithelium of the proboscis lining the gutter and the margins consists of short cylindrical ciliated cells, each with a nucleus in the centre. There are also glandular cells and ducts of



Text fig. 1—Transverse section of the proboscis, $\times 40$.

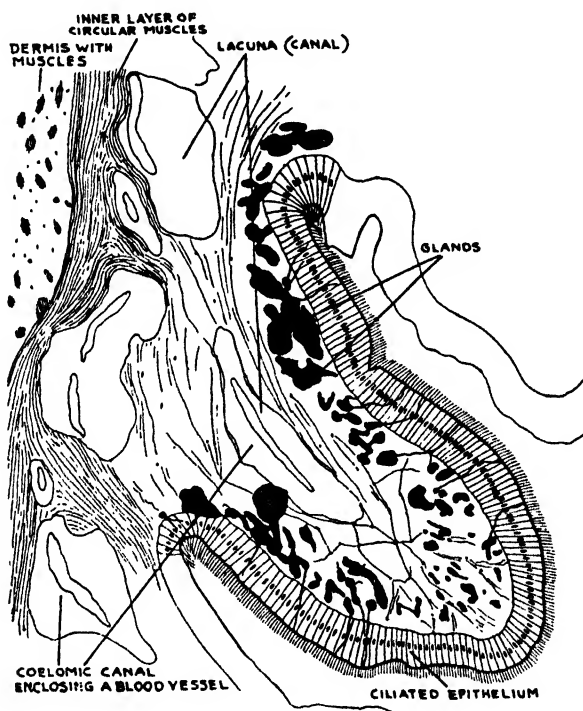


Text fig. 2—Dorsal surface of the proboscis, $\times 200$.

other glands in between these cells. These two surfaces of the proboscis, dorsal and ventral, have two different functions to perform; the dorsal surface is muscular and tactile while the ventral

forms the gutter to transport water and food into the mouth of the animal (Fig. 3).

(3) The Dermis. It is the principal tissue which forms the core of the proboscis. It forms the dense ground substance, in which are found connective tissue cells and fibres and muscles fibres forming a close network. The connective tissue between the inner layer of the circular muscles and the ventral epithelium is on the other hand loosely arranged. There are sinuses formed by the network of the coelomic canals crossing and re-crossing each other (Figs. 3 and 6). In the dermis are found bands of muscles which are smooth. These muscles are differently arranged :



Text Fig. 3—Ventral surface of the proboscis, $\times 200$.

(i) Circular muscles. There are two thin layers of the circular muscles; one immediately beneath the dorsal epidermis and outside the hypodermal connective tissue, while the other layer encircles the ventral surface between the dermis and the chain of the sinuses (lacunae). Contractions of these muscles, helped by the turgescence of the canals by inrushing of the body fluid, tend to lengthen the proboscis.

(ii) Longitudinal muscles. The bundles of longitudinal muscles are continuous with those of the trunk and are found mostly on the dorsal side. The contractions of these muscles tend to shorten the proboscis.

(iii) Oblique muscles. The oblique muscles form a part of the circular muscles. They run along the margins of the proboscis. Contractions and relaxations of these muscles change the form and the length of the gutter and the margins.

(iv) Dorso-Ventral muscles. These dorso-ventral muscles run from the dorsal to the ventral surface through the dermis. The contractions of these muscles tend to flatten the proboscis and make it more or less spade-like with the broad tip.

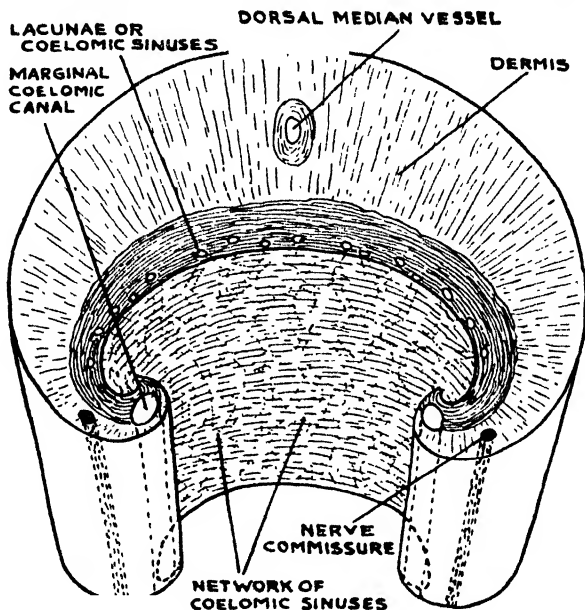
(4) Glandular tissue. It is found between the dorsal epithelium and the outer layer of the circular muscles. It consists of groups of individual gland cells. Some of these are more or less pear-shaped, having a long neck and a longer duct which passes through the epithelial layer and pierces through the cuticle to open on the dorsal surface, while others are more or less oval. (Figs. 1 and 2).

The glandular tissue on the ventral side on the other hand which is found in a loose connective tissue, consists of irregularly shaped gland cells with or without necks. The ducts are extremely thin and narrow. They open on the ventral surface after passing through the ciliated epithelium (Fig. 3).

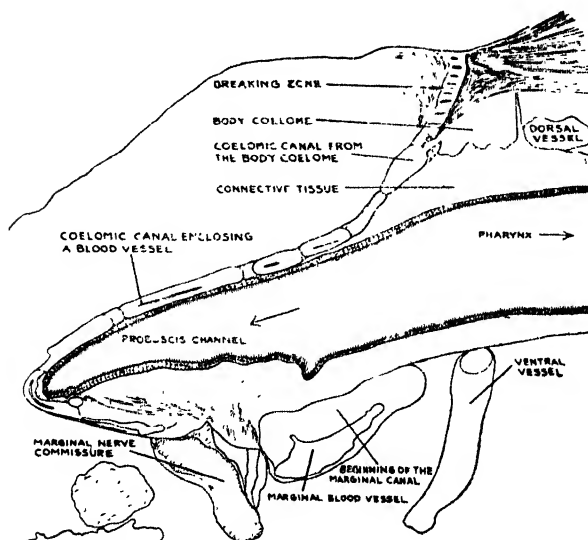
(5) Coelomic canals (Lacunae). In a transverse section a series of isolated canals or lacunae are seen forming a chain along the ventral surface (Figs. 1 and 4). They are found lying between the inner layer of the circular muscles and the loose connective tissue lying underneath. Each sinus is seen enclosing a vacuole which is nothing but a part of a blood vessel. The marginal sinuses (canals) are bigger than the rest.

The smaller sinuses are the cut ends of the coelomic canals which form a network in the loose connective tissue and also open into each other at the crossing points. These canals are branched off as secondary canals from the two big ones found along each margin of the proboscis. The latter (marginal canals) are the primary canals which are the direct continuations from the body coelome and are found running along the margin between the latter and nerve commissure on each side. These primary coelomic canals can be traced to the main body coelome in a series of transverse sections (Fig. 5). The presence of the network of the canals and inter-communications among them can be easily demonstrated. A coloured fluid when injected through any of the

sinuses, comes out through all other sinuses—big and small. The fluid while passing through the network of these canals leaves

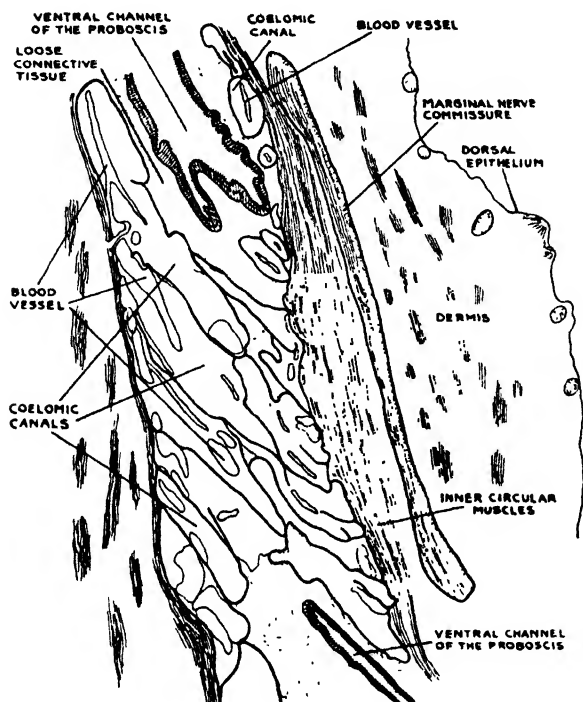


Text fig. 4—Showing diagrammatically a network of coelomic canals just beneath the ventral epithelium of the proboscis.



Text fig. 5—Median longitudinal section of the proboscis showing the origin of the marginal coelomic canals in the proboscis, $\times 40$.

its stain behind. By clearing the portion injected, a network can be made out (Fig. 4). An oblique sagittal section of the proboscis reveals the presence of this network (Fig. 6).



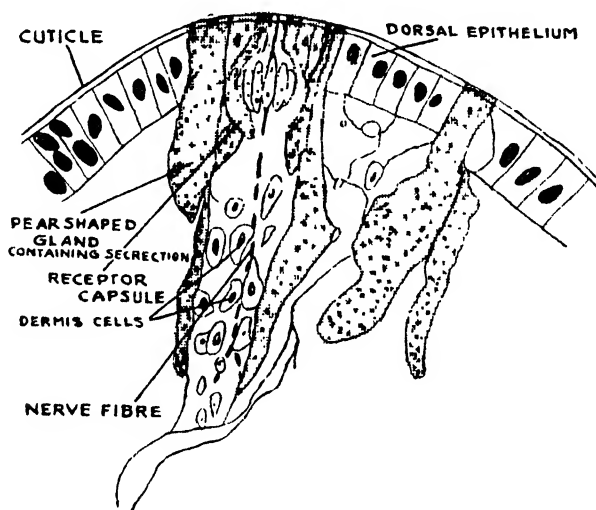
Text fig. 6—Oblique horizontal section of the proboscis showing the network of the coelomic canals, $\times 40$.

(6) Blood vessels. There are three main blood-vessels in the proboscis. One of them is the dorsal vessel which runs from the base to the tip of the proboscis almost through the centre of the dermis, while the other two form marginal vessels running parallel with the margins of the proboscis. All the blood-vessels give out branches which run through the tissue of the proboscis. The marginal vessels and their branches are, however, enclosed in the coelomic canals. These latter blood vessels can be differentiated from the coelomic canals by the fact that the former are rather well lined with the endothelium while the latter have a peritoneal lining and sometimes sexual cells and coelomic corpuscles are found in them.

The dorsal blood vessel is on the other hand, quite different in appearance from the marginal vessels. In a transverse section it

shows the endothelial lining and a thick layer of fibres. On the outside of the fibrous layer there is a thick covering of a dense non-cellular tissue. Along its course it sends out branches into the dermis.

(7) MARGINAL NERVE COMMISSURES (Figs. 1 and 6). There are two circum-pharyngeal commissures running along both the margins of the proboscis. Nerve branches are given off from these commissures which form a network in the dermis.

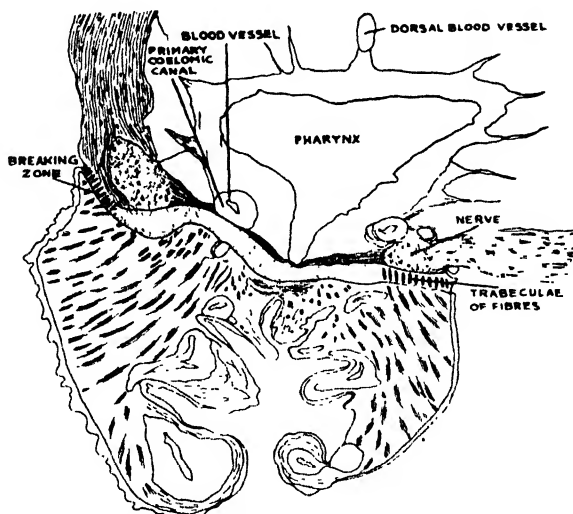


Text fig. 7—Showing a receptor capsule and pear-shaped glands on the dorsal surface of the proboscis, $\times 900$.

(8) CAPSULES OF RECEPTORS (Fig. 7). They are found in the dorsal epithelium, embedded partly in the dermis and partly in the epithelium. Each capsule is generally located in between many pear-shaped glands. It consists of the central neuro-epithelial cell having a short process at the outer end and longer and thinner one at the inner. The short process is the sensory hair which projects a little outside the dorsal surface. The longer process joins on to a small delicate nerve fibre which is given from one of the commissures. The side cells two or more on each side are the supporting cells. The whole structure is enclosed in the modified dermal tissue.

No receptor capsules are found on the ventral surface. Their absence may be due to the fact that the whole of the ventral surface is sensory.

BREAKING ZONE BETWEEN THE PROBOSCIS AND THE TRUNK OF THE BODY (Figs. 6 and 8). The proboscis can be easily detached or broken off from the trunk at the slightest irritation. In order to facilitate such an easy detachment, a zone is formed between the trunk and the proboscis, consisting of thin trabeculae of the connective and muscular tissue, the fibres of which bridge over the vacuolated space. These fibres snap asunder when the trunk and the proboscis are being contracted at the same time but in opposite directions. The proboscis falls off and the vacuolated space where the breaking zone is formed contracts and closes up. The fluid from the body-cavity is thus prevented from oozing to the outside by such a closing mechanism.



Text fig. 8—Showing the breaking zone of the proboscis, $\times 40$.

Functions of the proboscis. Some of the important functions which can be ascribed to this organ of *Thalassema* are :—

(i) **Transportation of food and water.** By forming a gutter on the ventral surface and by producing currents by ciliary movements of the ventral epithelium, water containing small organisms and sand particles is made to flow along the ventral surface into the mouth. In the secretion of the glands found along the ventral surface are caught small organisms, and particles of sand which are then carried into the alimentary canal with the water.

(ii) **Burrowing organ.** The coelomic spaces in the proboscis become turgid when filled with the coelomic fluid thus making the proboscis rigid for burrowing purposes into the soft sand or clay.

This turgid and hence rigid proboscis can be compared with the foot of a burrowing bivalve in which the turgidity of the organ is, however, due to the influx of the blood into it.

(iii) Respiration. The coelomic fluid contained in the coelomic canals of the proboscis performs a respiratory function. These canals line the inside of the ventral surface along which a continuous stream of fresh water is passing. Owing to a very thin partition between the coelomic fluid on one hand and water on the other, the former is thus able to give up its carbon dioxide into and take in oxygen from the latter. Besides oxygenation of the coelomic fluid, the blood contained in blood vessels is also oxygenated.

(iv) Besides discharging these important functions, the proboscis may act as an organ of touch and taste because of the presence of receptor capsules and sensory ventral epithelium.

(v) On account of its adhesiveness owing to secretion of the glands on the ventral surface, the proboscis may enable the animal to creep slowly. It has been seen in smaller specimens under observation that the ventral surface of the proboscis when completely flat, firmly adheres to the surface of the substratum. It then contracts and drags the animal slowly after it.

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COMMON SAGITTAE OF THE BOMBAY HARBOUR
(*With 3 Text and 3 Plate figures.*)

BY

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The present paper on the common sagittae of the Bombay Harbour is the second of the series of our papers on the common planktonic organisms of the Bombay Harbour being published in this journal. It is based on the plankton collected by us regularly at short intervals from October 1932 to February 1934 and at long intervals since then. These arrow-worms are usually found throughout the year and although colourless and transparent they attract one's notice by their darting movements.

All the arrow-worms found in the Bombay Harbour belong to the genus sagitta which is oceanic and has a world-wide distribution. It consists of about 30 species which have been "cursorily" described and include "a number of very similar forms" according to Fowler (2). We have therefore examined numerous local specimens and based on this investigation we have given here the characters of these species.

SAGITTA GARDINERI

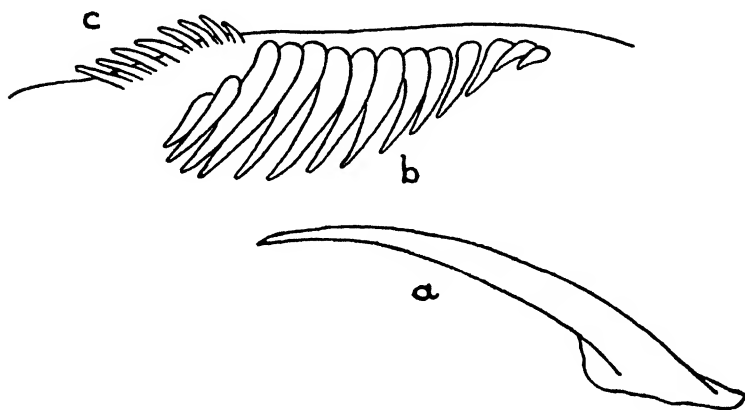
L. Doncaster. Chaetognatha: Fauna and Geography of the Maldive and Laccadive Archipelagoes, Vol. 1, p. 212, 1902.

CHARACTERS :—The body (Plate 1, Fig. 1) is spindle-shaped, transparent and thin-walled. In living and well-preserved specimens it is tumid, otherwise flaccid or contracted and wrinkled. The head is broad and short but appears rather small in contraction. There is a distinct neck without a collarette. The trunk is thickest in front of its middle. It tapers rapidly forward and gradually backward. The tail including the caudal fin is nearly one-fifth of the total length of the body, including the caudal fin, i.e. from the tip of the head to the tip of the caudal fin. It is marked off from the trunk by a slight constriction. The total length of the body varies from 5 mm. to 23 mm.

The anterior fins are narrow and short, beginning anteriorly behind the middle of the trunk. Their widest part is behind their middle. The posterior fins situated some distance behind the

anterior fins are equally short but broader. Their widest part is about the level of the tail-septum and they are situated more in its front than behind. The fin rays of the paired fins do not extend quite to the base. The caudal fin is large and rounded.

The 8 to 10 prehensile spines are slender and slightly curved (Text Fig. 1). The anterior set of teeth consists of 7 or 8 short and pointed teeth slightly projecting beyond the anterior edge of the head in the middle. The posterior set bends obliquely backward and consists of 9 to 16 similar teeth of which the middle ones are long.



Text fig. 1—Armature of *S. gardineri* 18 m.m. long.
a, prehensile spine ; b, posterior teeth ; c, anterior teeth.

The corona ciliata is not usually found even in living and freshly preserved specimens after staining with one per cent. methyl blue solution. Out of 50 specimens carefully examined only in 4 specimens it was partially seen and in one alone it was like what has been figured by Fowler. It was situated entirely on the head just behind the cerebral ganglion and resembled an hour-glass with the top knocked off. Even after staining no tactile bodies were discovered on any part of the body. The ventral ganglion is in front of the anterior fin at a distance of the length of the latter.

The intestine is a straight and laterally compressed tube which being less contractile than the bodywall appears slightly bent sideways in preserved specimens. The ovaries are usually short and stout and often curved outward at the tip. In a few large specimens they were found to extend beyond the posterior fins. In mature specimens the chambers in the tail segment are found to be full of sperm morulae. The latter are seen moving round, continuously inside them. The seminal vesicles are spherical and

close to the caudal fins. The distance between the genital openings was found to vary between ten and twelve per cent. of the total length of the body.

FORMULA OF *S. GARDINERI*

Total Length of the body in mm.	Percentage of distance between genital openings in total length.	Prehensile spines.	Anterior teeth.	Posterior teeth.
4.5	12	9	7	9
11	11	9	8	12
14.5	10.5	10	7 and 8	14
18	11	10	8	14
21	12	9	8	16

REMARKS: This species was abundantly found in winter. Although it was not found in the months of March, April, and May of 1933 later collections have shown that it is not altogether absent during these months. The drawing with the camera lucida of a specimen of this species (Plate 1, Fig. 1) shows also a small trematode inside the body-cavity in front of the ovaries. Such parasitic trematodes are occasionally found wriggling inside the specimens of this as well as other species.

Sagitta enflata and *S. hexaptera* are superficially similar to this species and have been recorded at some places on the West and East Coasts of India. *S. enflata* appears to be easily separable from this species by its shorter anterior fins and the considerably longer distance between its ventral ganglion and anterior fins, as seen by John (4). The ratio of this distance to the total length of the body has been observed by him to be twice or thrice that in *S. gardineri*. In this connection it may be pointed out that Fowler's camera lucida figure of *S. enflata* agrees with that of John's *S. gardineri* on this point and also in the matter of the percentage of the distance between the genital openings in the total length. In the absence of the original specimens for comparison it may be suggested that *S. gardineri* of Doncaster is really synonymous with *S. enflata* of Grassi as previously shown by Fowler and that *S. enflata* recorded by John at Madras is a different species. *S. hexaptera* can be readily distinguished by its few anterior and posterior teeth.

SAGITTA BEDOTI

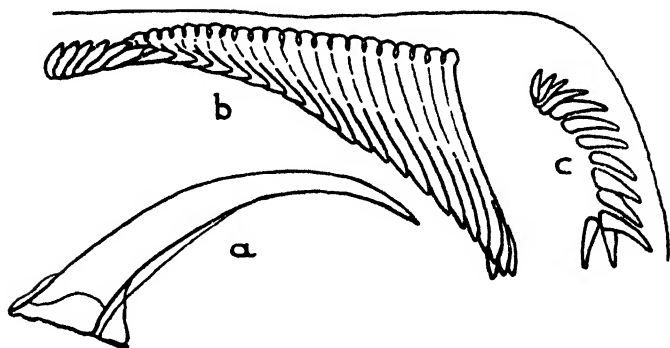
Ed. Béranek. Les Chetognathes de la Baie d'Amboine.
Revue Suisse de Zoologie. Tom. 111, p. 147, 1895.

CHARACTERS: The animal (Plate 1, Fig. 2) is like a short and

stout needle. The head is rather small and looks to the naked eye as an opaque end of the body in preserved specimens. Under a dissecting lens it is seen to be separated from the trunk by its slight dilatation. The end of the trunk behind it has a short but slight thickened epidermis which represents its collarette and makes this part of the trunk its neck. The trunk is firm and columnar with a slight bulge in the middle. In preserved specimens its sides often sink in and the trunk appears much narrow and the head more pronounced. The tail is about 30 per cent. of the total length and marked off from the trunk by a slight constriction. The total length of the animal varies between 5 mm. and 24 mm.

The anterior fins are long and wide posteriorly. They begin at the level of the ventral ganglion and gradually increase in width posteriorly. The fin rays start from the base. The posterior fins are broader than the anterior and lie more along the tail than along the trunk. Their widest part is quite behind the tail septum and they nearly reach the seminal vesicles. The distance between the anterior and the posterior fins is short but distinct. The caudal fin is roughly triangular.

There are 7 or 8 thick and strongly curved prehensile spines (Text Fig. 2). The anterior teeth vary from 10 to 13 and form a longitudinal row bending round the anterior edge of the head.



Text fig. 2—Armature of *S. bedoti* 23 mm. long.
a, prehensile spine; b, anterior teeth; c, posterior teeth.

The posterior teeth are numerous, brown and close set. Their number varies from 19 to 33. This set of teeth is more or less transverse with its one end curving backward dorsally and the other ventrally.

The corona ciliata is long, narrow and slightly sinuous. It begins in front of the eyes and extends behind for two-thirds of the

distance between the head and the ventral ganglion. Under the low power of the microscope the thin collarette is seen to be produced behind to the anterior fins in the form of a very thin but distinct epidermal lining. It becomes again visible in the interval between the anterior and the posterior fins. All over the trunk many transverse rows of tactile organs are seen. They appear as oval or circular deep blue spots when stained with methyl blue. Some tactile bodies are found on the caudal fin. Their sensory hairs appear to be stiff and straight. The ventral ganglion is small and situated one-fifth of the total length behind the anterior end.

The intestine often appears brown and baggy in preserved specimens. The ovaries are long and slender and were found to extend in some specimens beyond the posterior two-fifths of the length of the trunk. The ova inside are large and rounded and may make the ovary look septate. The female genital opening is situated on a conical papilla which stands out laterally. The testes contain sperm morulae which move round a longitudinal septum in each chamber. The seminal vesicles when tumid are spout-shaped and extend from the caudal to the posterior fin. Their external openings are situated anteriorly and directed outward. The distance between the genital openings was found to vary between 11 and 13 per cent.

FORMULA FOR *S. BEDOTI*

Total Length in mm.	Percentage of distance bet. genital open- ings in total L.	Prehensile spines.	Anterior teeth.	Posterior teeth.
23	...	8	13	29
15	11	8	13	30
13	11	8	11	26
4.7	13	8	13	19

REMARKS: This is the most common sagitta of Bombay and is found in fair numbers throughout the year. The length of usually found larger specimens varies between 10 mm. and 16 mm.

This species was created by Béraneck for preserved specimens from Amboina in which he could not see the corona ciliata. Later Doncaster provisionally created a new species viz. *S. polydon* for specimens from Maldiva and Laccadive Archipelagoes which chiefly differed from the former in possessing a corona ciliata. Fowler has combined these two and revised the diagnostic characters of the former.

This species markedly differs from all other sagittae by its larger numbers of anterior and posterior teeth. But many of them superficially resemble this species very closely and some of them like *S. neglecta*, *S. robusta*, *S. ferox*, *S. tenuis*, and *S. pulchra* are found along the East and West Coasts of South India. But this species can be clearly separated from them by some other easily observable characters. *S. neglecta* and *S. tenuis* distinctly differ from it by their longer distance between the genital openings. In *S. robusta* the corona ciliata does not extend so far toward the ventral ganglion. In *S. pulchra* and *S. ferox* the corona ciliata is equally long but in the former the anterior and posterior fins are very close together or touch each other and in the latter the anterior fin narrows slightly forward.

SAGITTA BOMBAYENSIS NOV. SP.

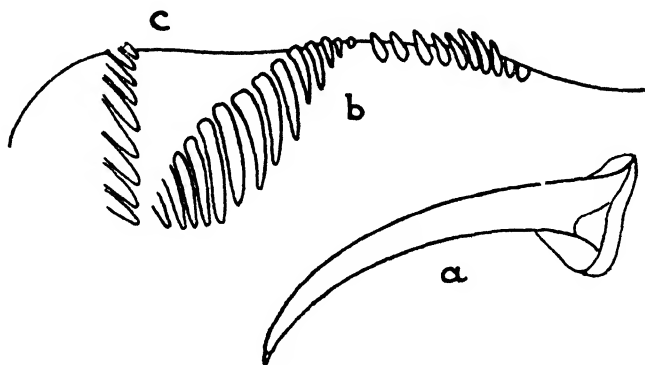
CHARACTERS: The body (Plate I, Fig. 3) is slender and often like a pin in shape. The head is broad and short but its breadth does not stand out as there is a thick collarette. The body wall is muscular and the body opaque in preservation. The collarette continues behind as a thin epidermal lining on the trunk. A little in front of the ventral ganglion the epidermis gradually thickens again and spreads out laterally to the beginning of the anterior fin. This thickening decreases gradually backward till it disappears in the middle of the tail segment. The trunk is columnar in its middle three-fifths and rapidly tapers forward and slightly backward. The constriction between the tail and the trunk is clearly seen. The tail is one-fourth of the body in length. The specimens vary from 4 mm. to 13 mm. in length.

The anterior fin is short and narrow and covered with the thickened epidermis along the base. It comes out of the latter at the beginning of the middle third of the body. It gradually widens backward and is a little less than one-fourth of the total length. The posterior fin is equally short and equally in front and behind the tail septum. Its widest part is in the middle of its caudal half and it gradually narrows forward. The anterior and posterior fins are separated by one-third of their length. The caudal fin is triangular with rounded corners.

There are 9 or 10 medium-sized curved prehensile spines (Text Fig. 3). The anterior teeth in large specimens vary between 8 and 12 and are arranged in a longitudinal row. The posterior teeth in large specimens vary between 16 and 25 and their row bends round backward to the mouth.

The corona ciliata is long, slightly sinuous and a little broad

anteriorly. It begins a little in front of the eyes and extends backward for two-thirds of the body in front of the ventral ganglion. The ventral ganglion is small and narrow and situated in front of the anterior fin at a distance of its own length. The tactile bodies are very numerous and arranged in many transverse rows. The sensory hairs give it a "hispid" appearance. They are also found on the caudal fin where they are arranged in two or four columns.



Text fig. 3—Armature of *S. bombayensis*, 13 mm. long,
seen from the ventral side.

a, prehensile spine; b, posterior teeth; c, anterior teeth.

The intestine is straight and narrow. The ovaries are long and linear and may extend beyond the posterior end of the ventral ganglion. The oviduct opens to the outside on a small papilla. In the testes of mature specimens sperms and not their morulae are seen. The seminal vesicles in living specimens appear as white, opaque and glistening bodies attached to the tail. They are spout-shaped with their external openings being anterior and directed outward. In mature specimens they extend from the caudal to the posterior fin. The distance between the genital openings is about 12 per cent. in large specimens.

FORMULA OF *S. BOMBAYENSIS*

Total length in mm.	Percentage of distance between genital openings in total length	Prehensile spines.	Anterior teeth.	Posterior teeth.
13	12	8	10	26
8	immature	8	5	11
5	immature	8	4	8

REMARKS : This species is present in the Bombay Harbour throughout the year but it appears in swarms during the South-West Monsoon.

It is characterised by the thickened epidermis nearly all through the length of the body. This thickened epidermis is seen even in very small specimens and distinguishes this species from all other species of *Sagitta* except *S. regularis* which is also provided with a similar thickening. The latter was described by T. Aida in 1897 from Japan and later recorded by Doncaster (1) from the Maldiva and Laccadive Archipelagoes. According to Doncaster, "This species is very small, rarely more than 5mm....The tail is one-third of the length of the whole. ...It (corona) lies entirely on the trunk." This kind of corona has been drawn under the camera lucida by Fowler from a specimen of this species. The Bombay specimens markedly differ from this species on all these points and also in the absence of the epidermal thickening anteriorly on the head. These differences are sufficient to raise the local specimens to the rank of another species. But as remarked by Fowler, if *S. regularis* is not sufficiently observed and adequately described the local species may merge into it. We have therefore provisionally named it as *S. bombayensis* in order to point out its differences from *S. regularis* of Aida and Doncaster. Dr. C. C. John has kindly seen our specimens and approved of our plan.

The following table gives the numbers of the specimens of these species found in the largest catches of half-hourly tow-nettings of each month in the year 1933 and roughly indicates the seasonal variation in the population of these species in the Bombay Harbour at the surface.

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Spt.	Oct.	Nov.	Dec.
<i>S. gardineri</i> ..	130	20	...	...	...	16	97	187	267	60	728	1028
<i>S. bedoti</i> ...	590	260	7	803	375	105	428	753	604	32	110	203
<i>S. bombayensis</i>	567	79	8	688	183	1336	1243	184	378	30	62	165

ACKNOWLEDGMENTS

We take this opportunity to express our indebtedness to the University of Bombay for financially helping us in this investigation. We have also to thank the Director of the Zoological Survey

PLATE I

Outline drawings by camera lucida

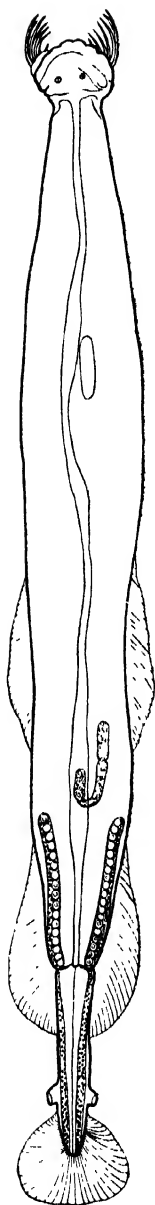


Fig. 1—*S. gardineri*
21 mm. long.

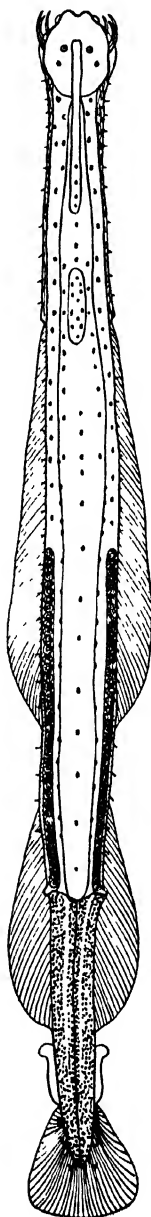


Fig. 2—*S. bedoti* 15 mm.
long.

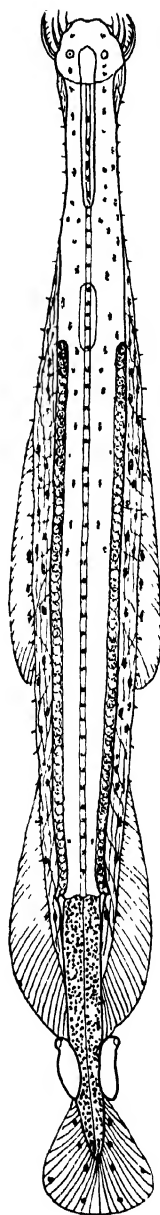


Fig. 3—*S. bombayensis*
13 mm. long.

of India and the Honorary Secretary of the Bombay Natural History Society for the loan of reference books.

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2. Fowler, G. H. Chaetognatha of the Siboga Expedition XI, Siboga-Expeditie XXI, Leiden, 1906.
3. Grassi, B. Chetognati. Fauna und Flora des Golfes von Neapel, IV, Leipzig, 1883.
4. John, C. C. Sagitta of the Madras Coast. Bulletin of the Madras Government Museum New Series--Nat His. Section, Vol. III, No. 4, 1933.

THE ANATOMY OF DENDROSTOMA SEIGNIFER
SELENKA ET DE MAN

(Continued from *Bom. Uni. Jour. Vol. III* 5 pp. 102-113)
(With 12 Text-figures)

BY

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THE BLOOD VASCULAR SYSTEM

The blood vascular system will be described under three separate heads, namely, the circulating fluid the blood, the vascular structures and the course of circulation.

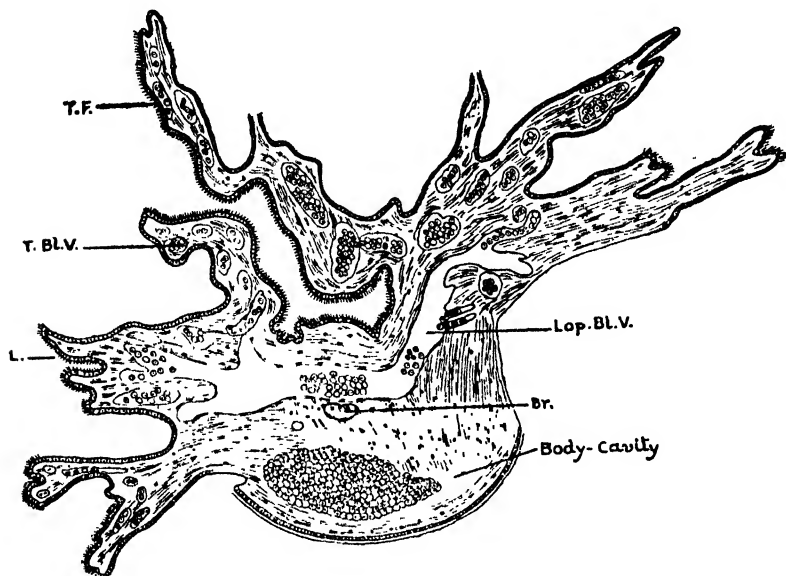
THE CIRCULATING FLUID. The blood which flows through the vessels is a madder red coaguable liquid containing numerous corpuscles in suspension. The plasma itself is colourless but the madder red colour of the blood is due to a kind of respiratory pigment—"haemerythrin" contained in the corpuscles which are of one kind only and similar to those smaller corpuscles found in the coelomic fluid of the body cavity.

THE VASCULAR STRUCTURES. The vascular structures principally include (1) the single dorsal vessel which is often called the heart (2) the circular or lophophoral sinus surrounding the pharynx anterior to the oesophageal nerve commissure (Fig. 1. Lop. Bl. V.) and (3) the tentacular blood vessels (Fig. 1, T. Bl. V.)

1. **THE DORSAL BLOOD VESSEL.** The vessel commences as a posterior median prolongation of the lophophoral sinus. It runs posteriorly along the mid-dorsal region of the pharynx and the oesophagus, and ends blindly at the place where the oesophagus takes an upward course. It can be divided into two parts according to the presence or absence of blind processes. In the first part of this vessel which is enclosed with pharynx and the oesophagus in the tube formed of the retractor muscles, there are no blind caeca, while in the second part it separates out from the sheath and gives out numerous blind caeca from all its sides.

The following are the histological elements in the dorsal blood-vessel (Fig. 1 A). The peritoneum (A.P.) forms the external layer while the innermost layer is formed by a distinct epithelial lining similar to that found in the tentacular vessels. Between these two layers there is a thin connective tissue, containing fibres—muscular as well as white connective tissue (A.P.) The connective tissue

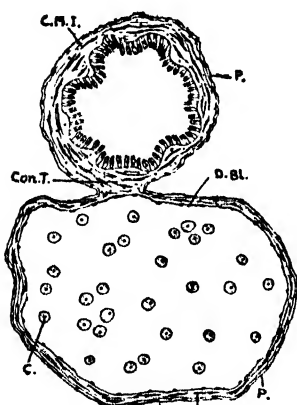
with the external peritoneal layer appears to be continuous with that on the wall of the oesophagus. This connective tissue between the oesophagus and the blood vessel may initiate the rhythmic contractions in the latter when the former is undergoing peristaltic movements.



Text fig. 1—An oblique section passing through the tentacular region $\times 40$.

Br: Brain; L: cilia; Lop. Bl. V.: Lophophoral blood sinus;

T. Bl. V.: Tentacular blood vessel; T. F.: Tentacular filament.



Text fig. 1A—T. S. Passing through the oesophagus and the dorsal blood vessel showing that the connective tissue of the oesophagus is continuous with that of the blood vessel.

C.: Blood corpuscle;

Con. T.: connective tissue;

D. Bl.: Dorsal blood vessel;

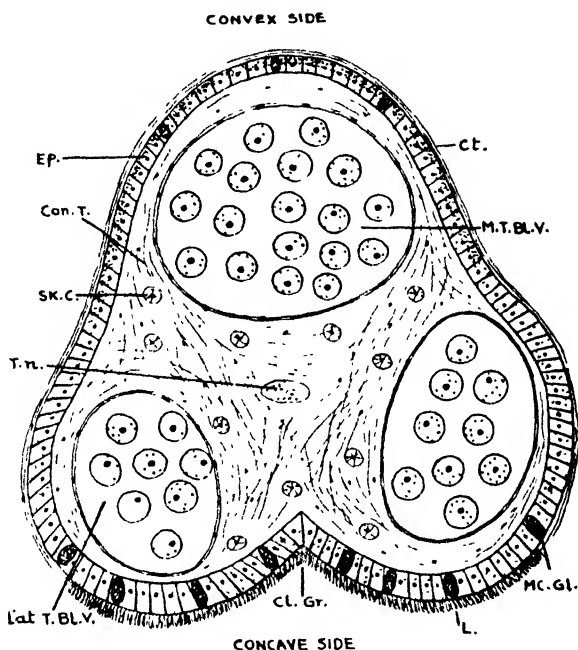
P: Peritoneum $\times 400$.

2. THE CIRCULAR OR LOPHOPHORAL SINUS. This sinus surrounds the pharynx anterior to the oesophageal nerve commissure (Fig. 1 Lop. Bl. V).

3. **THE TENTACULAR BLOOD VESSELS.** The filament appears triangular in shape with round corners in a transverse section.

Histology of the tentacular filament (Fig. 2). Externally each tentacle is covered over with a thin layer of the cuticle. Below it lies the epidermal layer, the epithelial cells of which are of two sorts :—

- (i) Ciliated columnar cells on the concave surface,
- (ii) Cubical non-ciliated cells on the convex and the lateral sides. These cells are covered over as already mentioned by the cuticular layer.



Text fig. 2—T.S. of a branchial filament showing the three tentacular blood vessels.

Cl. Gr. : ciliated groove; Con. T. : connective tissue; Ct. : cuticle;

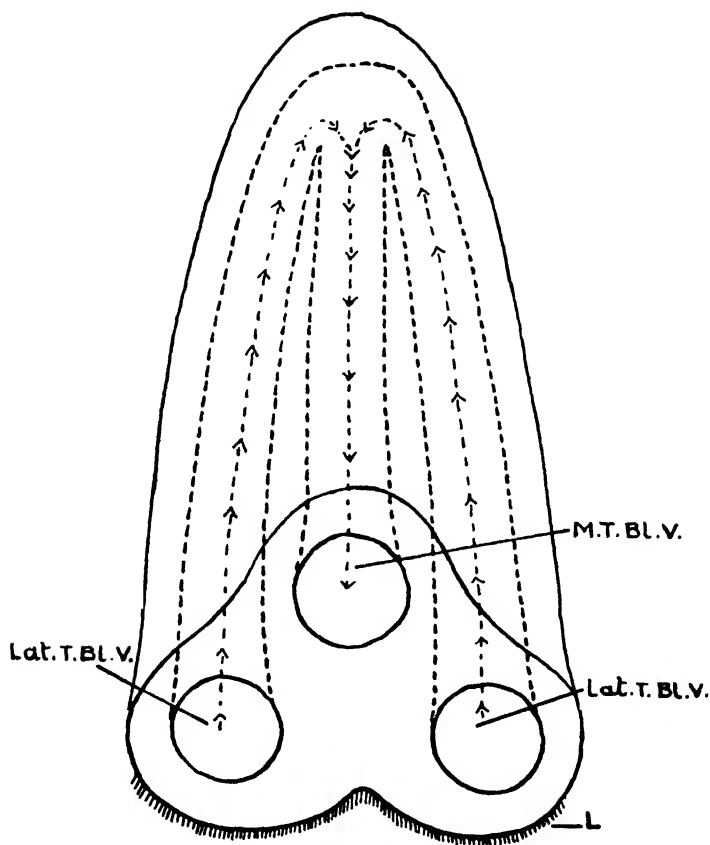
Dp. : Epidermis; L. : cilia; Lat. T. Bl. : Lateral tentacular blood vessel; M. T. Bl. V. : Median tentacular blood vessel;

Mc. Gl. Mucous gland; S.K.C. : Skeletal cell;

T.n. : Tentacular nerve. $\times 400$.

There are a few unicellular glands on the convex side and in between the ciliated cells (Mc. Gl.). These glands seem to secrete mucus which forms a string which is washed into the mouth by the current of water and which entangles minute particles of organic substances of food and which therefore helps the animal in catching its food.

Below the epidermal layer is found the connective tissue which nearly fills the core of the tentacle. Enclosed in the connective tissue (Con. T.) are found three blood vessels one at each rounded corner. The middle of the blood vessel which is situated at the convex side is larger than the other two (M.T.Bl. V ; Lat. T. Bl. V.) Each blood vessel is lined by a delicate layer of



Text fig. 3—A diagram showing the connection of the two lateral vessels with the median vessel at the apex in the tentacular filament : L ; cilia ;
 Lat. T. Bl. V. : Lateral tentacular blood vessel ;
 M.T.Bl.V. : Median tentacular blood vessel.

endothelial cells of which the nuclei are more prominent. The connective tissue consists of fine fibres traversing in all directions with a few prominent rounded cells with a distinct nucleus. These cells are similar to those described by Shipley¹ in *Phymosoma* as "Skeletal cells". Besides these there are also muscle fibres

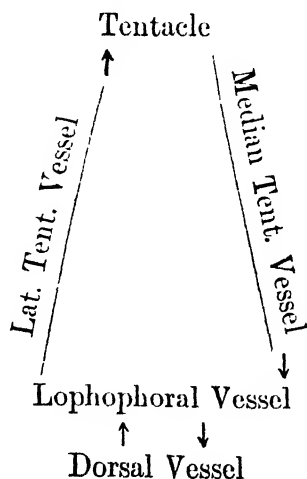
1. Shipley A. E. (1890) on *Phymosoma* *varians* Quarterly J. Micr. Soc. London. Vol. 31, p. 1.

embedded in the connective tissue. The tentacle is richly supplied with nerves. The main tentacular nerve given off from the circumoesophageal commissure runs through the connective tissue matrix of the tentacle. This nerve gives off numerous delicate branches to all the parts of the tentacular filament.

THE COURSE OF CIRCULATION: The dorsal blood vessel with its rhythmical contractions initiated by the peristaltic movements of the oesophagus is considered to act as the heart. A wave of contraction appears to start either at its anterior or posterior end and to drive the fluid slowly to the opposite end. The current after a very short time is reversed in its direction and then the blood is seen to be flowing in the opposite direction.

When the course of circulation is forward, the dorsal vessel empties its contents into the lophophoral sinus from which it goes to the tentacular vessels. The blood in the lophophoral sinus passes to each of the tentacular filament through the two lateral vessels and then turns back to the base of the filament through the single median vessel (fig. 3). After an interval of about ten to fifteen seconds the direction of the flow of the blood is reversed and some of the blood in the lateral vessels flows back to the lophophoral sinus, but the direction of the blood current in the median vessel remains all the while the same and is never reversed. Consequently the aerated blood is collected in the lophophoral sinus and when the direction of the peristaltic movements of the dorsal vessel is changed the lophophoral sinus empties its contents into it. Again after a lapse of about ten to fifteen seconds, there is a wave of contraction from behind and the whole process is repeated as before.

Diagrammatic representation of the course of circulation :



THE NERVOUS SYSTEM

The nervous system is divided into two main parts; the central and the peripheral. The former comprises the brain and the ventral nerve cord, while the latter consists of the nerves from the brain (the cerebral nerves), the nerves to the bodywall, and the nerve plexuses on the digestive tract, the spindle muscle, the bodywall, the retractor muscles etc.

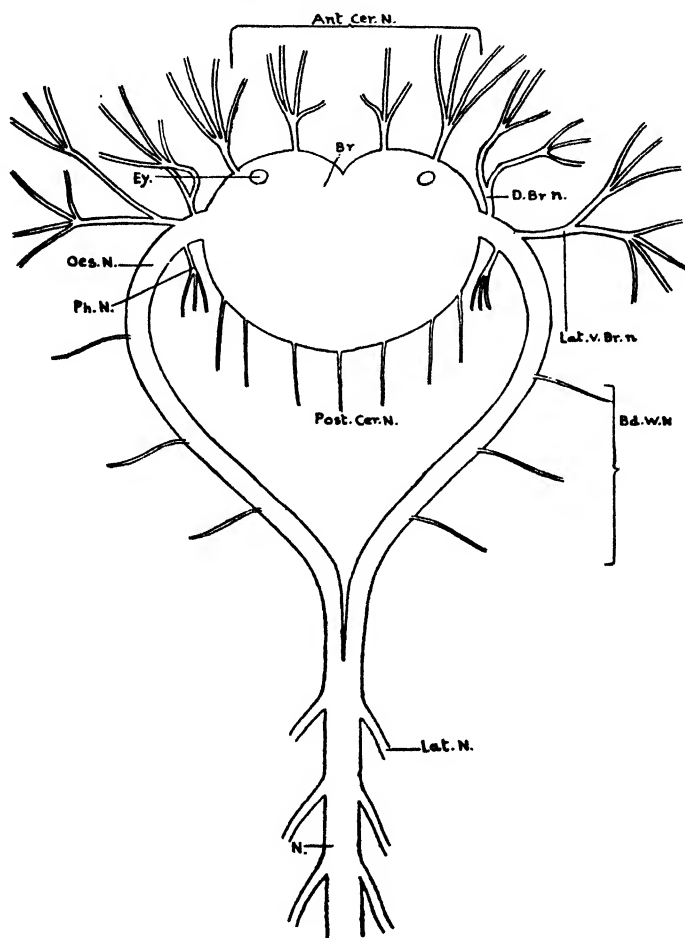
1. THE CENTRAL NERVOUS SYSTEMS:—The brain or the cerebral ganglia measuring about 0.6 mm. in a specimen of 3.7 cms. length has a heart-shaped outline although it is bilobed (Fig. 4 Br.). When viewed dorsally the posterior side appears to be convex while anteriorly are found two prominent lobes with a shallow groove between them. Close to its anterior margin are found embedded two small black spots usually spoken of as the "eyes" or the Sense pits (Figs. 4 and 6 Ey.). Their ventral surface is directly in contact with the dorsal vessel, while the ventro-lateral margins are abutting against the sides of the pharynx. The dorsal surface on the other hand is free in the body cavity.

The histological structure. The brain substance is made up of nerve fibres in the centre and nucleal cells at the periphery (Fig. 6). There are, however, no nerve cells towards the ventral margin, but it is mainly occupied by nerve fibres from the central region. This ventral margin as already stated above comes in contact with the dorsal blood-vessel.

The nerve cells are generally small with deeply stained central nuclei. They may be unipolar or bipolar. At the postero-dorsal angle of the brain are found a few peculiar bodies known as "giant cells". These cells are about four times bigger than the ordinary nerve cells and are generally unipolar. They are more or less pear-shaped and their nuclei are relatively smaller in proportion to their bulk and are located towards the base. Such giant cells are not, however, found anywhere else in the nervous system.

The Ventral Nerve cord: The ventral nerve cord is formed by the meeting of the two circumoesophageal commissures issuing one from each side of the brain (Fig. 4. Oes. N.). After its formation, it shows no trace at all either of its division into two halves as in annelids or concentration of nerve cells in any particular region or places along its course. It is attached throughout the ventral bodywall partly by the peripheral nerves and partly by the connective tissue sheath which forms the external covering as it runs along the ventral surface of the body as a straight filament. It is somewhat flattened in the region of the introvert while it gradually becomes cylindrical towards the posterior end where it

terminates in two or three unsymmetrical slender nerves which enter the bodywall. There is no ganglionic swelling at the termination of the cord as in *Sipunculus*'.



Text fig. 4—The Central Nervous System.

Ant. Cer. N. : Anterior cerebral nerves; Bd. W. N. : Nerves to the bodywall; Br : Brain; D. Br. N.: Dorsal branchial nerves; Ey : Eye; Lat. N.: Lateral nerves; Lat. V. Br.n. : Lateral and ventral branchial nerves; N. : Ventral nerves; Oes. N. : Circumoesophageal nerve; Ph. N. : Pharyngeal nerve; Post. Cer. N. : Posterior cerebral nerves.

The Structure of the Nerve cord : In a transverse section the structure of the nerve cord appears to be as follows: Externally there is a peritoneal membrane; next to it on the inside is formed a thick connective tissue in which are seen fibres and nuclei of the two bundles of the longitudinal muscle fibres in the

lateral aspect of the cord. Then comes the central nervous mass, in which nerve cells are aggregated on the ventral side of the cord and the fibrous mass on the dorsal. This arrangement is quite the reverse of that found in the brain substance.

The lateral longitudinal muscle fibres in the connective tissue of the nerve cord bring about the contraction and extension of the cord corresponding with the movements of the bodywall of the animal.

II. THE PERIPHERAL NERVOUS SYSTEM. It consists of (1) cerebral nerves and (2) nerve rings from the ventral nerve cord in the bodywall and (3) the nerve plexuses.

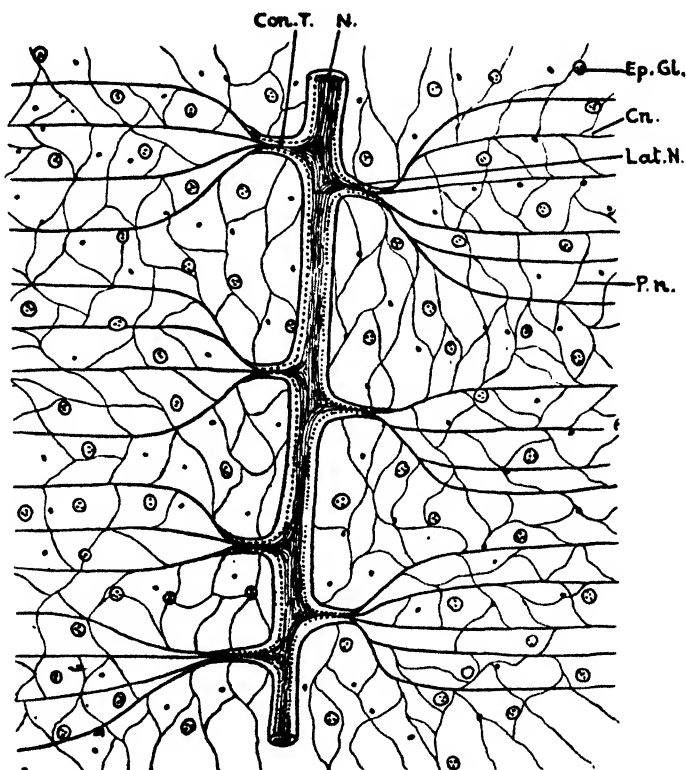
(1) *Cerebral Nerves* :—(a) anterior cerebral nerves : From the anterior convex lobes of the brain are given small nerves two on each side of the groove which supply the skin of the anterior region of the animal (Fig. 4 Ant. Cer. N.). (b) Posterior cerebral nerves : From the posterior part of the brain are given off numerous nerves to the retractor muscles. The large circumoesophageal commissure also gives out after encircling the pharynx meets its fellow from the other side to form the ventral cord. Each of them supply nerves to the anterior parts of the body.

Three nerves are given from each of the circumoesophageal commissure. The first supplies nerve to the dorsal branchiae (D. Br. n.) The second nerve which is perhaps the largest arises from the middle of the commissural nerve and supplies the lateral and the ventral branchiae (Lat. V. Br. n.). These tentacular nerves branch out on their course and one branch is supplied to each filament of the tentacle, the nerve filament running through its centre of the filament beneath the ciliated groove (Fig. 2. T. n.). The third commissural branch which is shorter arises from the postero-ventral side and supplies nerves to the pharynx (Fig. 4 Ph. N.). Numerous small nerves are given off to the body-wall from the lateral side of each of the circumoesophageal commissural nerve before it forms the ventral nerve cord (Fig. 4. Bd. W.N.).

Nerve rings from the ventral nerve cord in the body-wall. There are innumerable lateral nerves arising along the whole length of the cord on both sides but there is no indication of any metamerism or regular repetition of any kind in the arrangement of their nerves (Fig. 5). Each nerve takes its origin from the lateral side of the nerve cord. It is surrounded at its base (before it divides), by a thin connective tissue sheath, containing a few elastic fibres (Con. T.). Each lateral nerve first passes outward and immediately bends ventrally to enter the body-wall. It then divides and carries branches in between the two layers of the bodymuscles. Each

branch of the lateral nerve runs from one side of the cord to the other along the dorsal aspect of the body, thus almost encircling the latter (Cn). The ring is, however, not complete as it is on the ventral side below the nerve cord.

The bodywall is richly supplied with a network of these nerve rings. Each of them is subdivided and each subdivision supplies



Text fig. 5—Surface view of the skin showing the network formed by lateral nerves.

C. n. : Circular nerve fibres ; Con. T. : Connective tissue ; Ep. Gl. : Epidermal gland ; Lat. N. : Lateral nerve ; P. n. : Peritoneal nerve plexus $\times 40$.

a particular area, such as the peritoneal layer, (P. n.), the sub-epidermal area etc. In the sub-epidermal area, however, the nerves form an intricate network which supplies nerves to the epidermal organs.

3. NERVE PLEXUS : They are found at different places forming the sub-epidermal plexus, the plexus on the wall of the alimentary canal, plexus on the retractor muscles etc.

SENSE ORGANS

The Epidermal organs or "The Sense papillae"—The whole of the external epidermal layer is sensory, that is, tactile in function but there are a few localised sense organs of which the structure and position is already described in connection with the epidermis and its organs in the first part. The function of these organs seems to be both sensory and protective. Their cells secrete mucus for covering and ultimately removing foreign bodies attached to the external surface of the animal and play an important rôle in bringing about the contraction of the whole body, thus exposing the minimum surface of the animal to the outside world. The contraction of the animal which is effected by a nervous mechanism is described below.

Each cell is provided with a sensory hairlike process at the distal end. This process is connected with the sub-epidermal nerve plexus which is linked with the nerve rings. The latter as described above from the main branches given off from the ventral nerve cord. At the slightest disturbance at the external surface of the body, the sensory stimulus which is carried to the ventral nerve cord, through several connecting nerve links causes the contraction of the longitudinal body muscles and thereby brings about the shortening of the whole body.

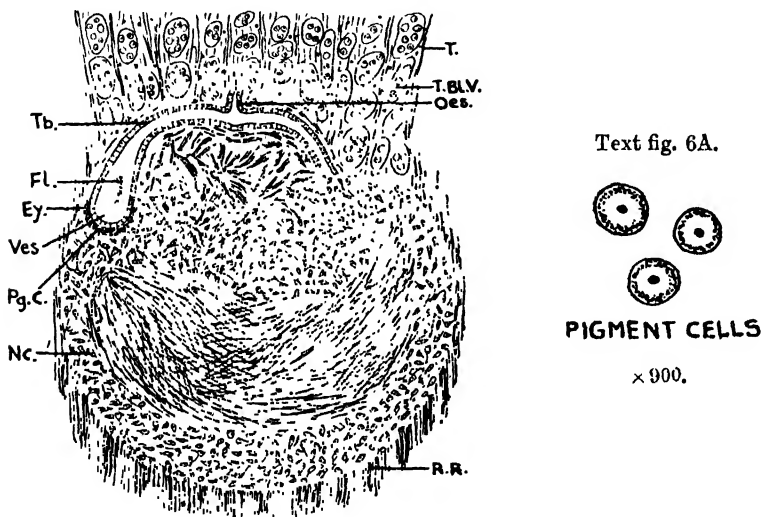
There is a difference, however, in the nature of the stimulus and hence the response is also different. A slight disturbance or irritation at any external surface of the body may cause only secretion of mucus from the cells of the papillae to flow at that region, in order to remove the source of irritation, but the continued disturbance at the same place may bring about the contraction of the whole body through the nervous mechanism already described.

Another function which has been attributed by some observers to these glandular cells is that their secretion seems to soften and to dissolve soft parts of stones or coral rock in which sipunculoids burrow¹.

2. The "Sensory pits" or the "Eyes". These sensory pits which are sometimes referred to as "eyes" are not well developed in this animal. They constitute a pair, one at each antero-lateral margin of each lobe of the brain (Fig. 4 Ey.)

1. Shipley A. E. (1890). *Phyrosoma varians* quarterly J. Mier. Soc Vol. 31. p. 1.

Each sensory pit (Fig. 6) consists of two parts. Pigmented vesicular swelling (Ves) embedded in the substance of the brain and tubular structure (6 Tb.) in continuation of the swelling. The tubular portion passes outwards and horizontal to the long axis of the body, upto the mid-dorsal line, to meet the one from the other side and then to open by a common short vertical channel into the oesophagus (oes) just anterior to the cerebral lobes. The vesicular swelling embedded in the substance of the brain contains a homogeneous co-agulable fluid (Fl.), probably a product of secretion of its living cells.



Text fig. 6—Horizontal section of the brain showing the origin of the duct from each of the sensory pits and their common opening into the oesophagus $\times 40$.

Ey : Eye ; Fl : Fluid ; Nc. : Nerve cell ; Oes : Oesophagus ; Pg. c. : Pigment cell ; R. R. : Retractor muscle ; T : Tentacle ; Tb : Tubular Portion ;

T. Bl. V. : Tentacular blood vessel ; Ves : Vesicular portion.

HISTOLOGICAL STRUCTURE. The layer lining the sensory pit is one cell thick. The cells are elongated, more or less columnar with granular protoplasm and the nucleus at the proximal or narrow end of the cell. None of these cells is ciliated as described in the "cerebral organs" of other sipunculoids. The arrangement of these cells seems to be more definite towards the inner or the vesicular portion.

The vesicular swelling of the sense pit organ is linked with a layer of pigment cells (Fig. 6 and 6A Pg. e.) four to five cells thick. Each cell is round having a prominent nucleus at the centre. The pigment granules are, however, restricted towards the outer

periphery of the cell. The black colour of the sense pit which is seen from outside is due to these pigment cells.

Functions of the Sense Pits. From its relation with the oesophagus, the nature of the function of these sense pits seems to be different from that of similar "cerebral organ" either of sipunulus or phymosoma. In the case of Phymosoma it is said that these act as rudimentary eyes to distinguish darkness from light¹. Therefore pigment cells in Dendrostoma are not photosensitive and therefore cannot be regarded as photoreceptors. Obviously they cannot function as visual organs as vision requires, the projection of a focused image of the source of light upon suitable photoreceptors. At the same time the presence of pigment cells cannot be explained satisfactorily. It may be that the black pigment may not always respond to light stimulus.

Another function attributed sometimes to these organs, in other Sipunuloids, is that, they are tactile and sensory in function. But since the sense pits in Dendrostoma are in no way connected with the outside world and they open into the oesophagus, it is futile to suggest that they also perform the similar function here.

They may act as statocysts or balancing organs as in other animals such as mollusca.

It may be strongly presumed that they may act as water testing organs. The water that passes through the oesophagus into the alimentary canal may be tested at the spot where these organs open into the oesophagus and in the case of unsuitable water, the mouth may be closed and this water may no longer pass into the alimentary canal. This sense organ can favourably be compared to the Jacobson's organ in the craniata or the osphradium in mollusca.

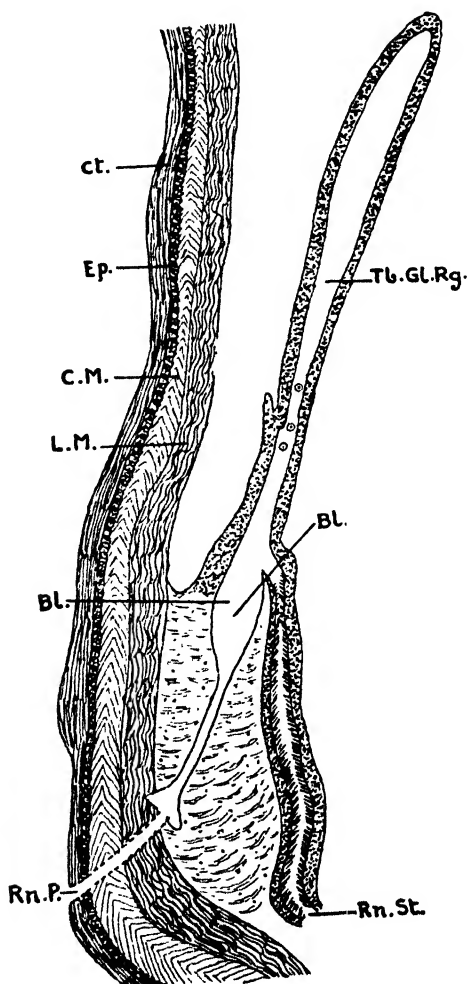
THE EXCRETORY SYSTEM

In Dendrostoma the nephridia or the excretory organs are in the form of a single pair of "brown tubes". They are situated far forward at the anterior end of the animal, their external openings (nephridiopores) being a little posterior to that of the anus. They lie on either side of the mid-ventral line, a little distance away from the nerve cord.

Each nephridium is nearly a straight tube of a yellowish colour, very mobile in the living condition and due to the muscle coat of its wall, the organ is capable of being shortened and elongated and also of twisted into a variety of shapes. The body of the nephridium hangs free in the coelom from the point of its attachment to the body-wall at the external opening.

1. Shipley, Cambridge Natural History Vol. II, 1901, p. 417.

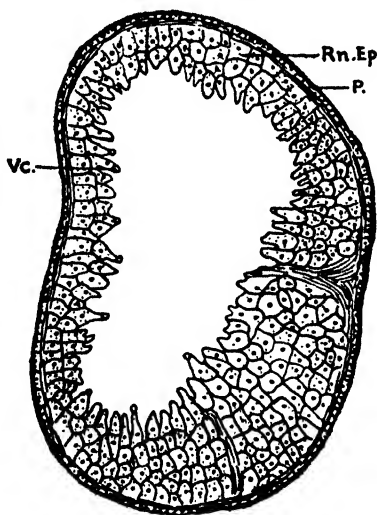
In each nephridium (Fig. 7) three separate regions can be recognised. The nephrostome region commencing with a funnel like orifice fringed with long cilia and opening into the body cavity, the body of the nephridium which is tubular and glandular region (Tb. Gl. Rg.), and the nephridiopore region which is a muscular sac opening to the exterior by the nephridiopore through which the products of excretion are from time to time thrown out by the contraction of its walls.



Text fig. 7—L. S. of brown tube showing the arrangement of the internal and external openings.

BL : Bladder ; C.M. : Circular muscle layer ; Ct. : Cuticle ; Ep. : Epidermis ;
L. M. : Longitudinal muscles ; Rn. P. : Nephridiopore ; Rn. St. : Nephrostome ;
Tb. Gl. Rg. : Tubular glandular region $\times 40$.

The Nephrostome and the nephridiopore. The nephrostome (Rn. St.) consists of a ciliated lip and is situated near the external opening (Rn. P.). The external opening is situated just behind the internal and communicates with the outside by a short neck leading from the bladder (Bl.) to be described later. The nephridiopore (Rn. P.) situated at the ventro-lateral aspect of the body is surrounded by a thickened ring of connective tissue intermixed with circular muscle fibres forming a sphinkter. The close proximity of these two pores the nephridiopore and the nephrostoma seems to indicate that the nephridium is doubled upon itself during the course of development. The body of the nephridium may again be divided into two parts, namely, the anterior swollen and nonglandular region the bladder (Bl.), and posterior glandular portion of the body the posterior prolongation of the bladder. The diameter of the bladder is about three or four times that of the posterior tubular portion, the single lumen of which is, however, partially divided by a number of septa projecting into it.



Text fig. 8—T.S. of the brown tube passing through the glandular region.

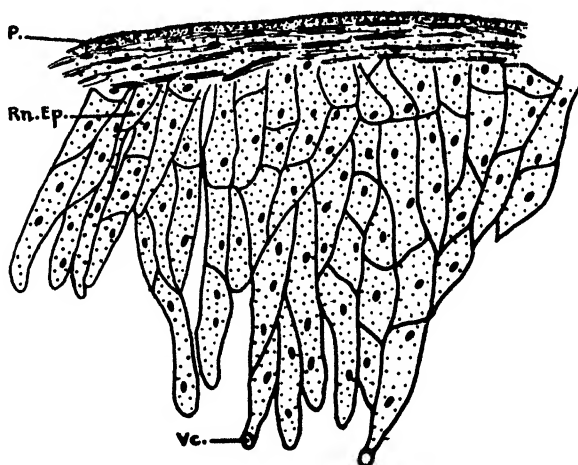
P : Peritoneum ; Rn. Ep : Renal epithelium ; Vc : vesicle. $\times 200$.

Minute histological structure of the body of the Nephridium.

(a) The bladder. Three layers can be recognised in the wall of the bladder, namely, the external peritoneal layer, the middle of irregularly arranged muscle fibres and the innermost single layer of cubical cells.

(b) Tubular glandular portion. (Figs. 8 and 9). Externally the nephridium is covered by the peritoneum some of the cells of which are ciliated (P.). This layer is essentially distinguishable from the nephridial cells by its avidity for staining reagents and also by the absence of secreting granules.

Next to the peritoneum there is a thin layer of connective tissue matrix in which are found strong circular and longitudinal muscle fibres. The internal epithelium consists of cells in many tiers which project into lumen of the tube (Rn. Ep). The cells are extremely long and are loaded with fine yellowish granules which seem to be waste nitrogenous products of the body-fluid. In living animals these cells are found to possess at their distal extremities many large thin walled vesicles (Ve.), which are thrown off from time to time into the lumen of the tube. These vesicles in the lumen resemble more or less drops of oil, when examined in a living condition. It is probable that the excretory products of the nephridial cells are stored up in these vesicles before being discharged together with the vesicles themselves.



Text fig. 9—A portion of the same seen under a high power.

P : Peritoneum ; Rn. Ep. : Renal epithelium ; Ve : Vesicle. $\times 270$.

The hemispherical cups or depressions between the flattened epithelium, described by Shipley in *Phymosoma*, are absent in this animal¹. The excretory soluble products appear to be absorbed directly through the peritoneal layer into the nephridial cells and form vesicles while the nephrostome of the nephridium functions as the inner opening of a gonoduct.

1. Shipley A. E. (1890). On *Phymosoma varians*, J. M. S. Vol. 31, p. 1.

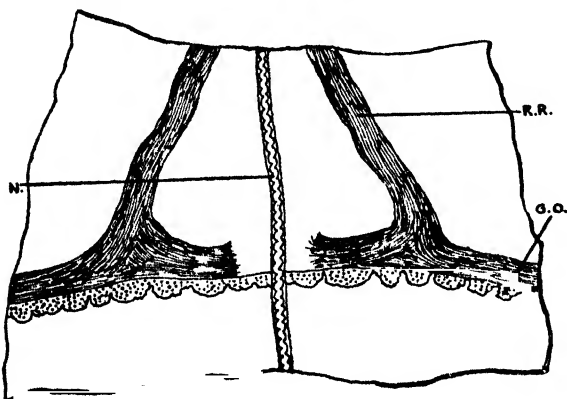
Other solid elements besides the vesicles in the lumen of the body of the nephridium are eggs in the female and spermatozoa in the male, and also the coelomic corpuscles. The presence of the latter escaped the notice of many observers who have therefore maintained that the nephrostome has the power of selecting the generative cells only when they come within their reach while they reject coelomic corpuscles.

As a rule two is the normal number of nephridia, but some five or six stray cases are met with in which the animals are found to possess sometimes three nephridia two on one and one on the other or at times only, that on the right or left being absent.

Besides being excretory, the nephridium acts as a gonoduct, the genital cells, either ova or sperms are taken in through the nephrostome and discharged to the outside through the nephridiopore.

REPRODUCTIVE SYSTEM

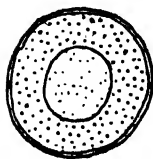
The animal is uni-sexual. There are no external characters by means of which the two sexes can be distinguished from outside. In both males and females, there is absolutely no difference either in size, shape or colour of the animal. The testis and ovary are found in the same position in the two sexes and cannot be distinguished from each other without the aid of a microscope. Each gonad forms a transverse ridge at the posterior edge of the retractor muscle, near its attachment to the body-wall and extends across the median line just below the ventral nerve cord (Fig. 10, G. O.) This ridge is formed of modified peritoneal cells which



Text fig. 10—A view of the generative organs at the base of the two retractor Muscles (R. R.). The ventral nerve cord (N.) lies between the muscles and the generative ridge.

became modified, in the case of female, into ova and in the case of male into the mother cells of spermatozoa. The free end of the genital ridge is irregular and this irregularity gives it a frilled appearance.

Eggs break away from the ovary in their early stage of development, but they increase in size whilst still floating in the nutritive coelomic fluid. Each of them is round in shape, with granular protoplasm and a prominent central nucleus which occupies the major portion of the egg (Fig. 11). The latter secretes a thick membrane around its body. There is no micropyle.



Text fig. 11

Like the eggs the mother cells of spermatozoa break away in an immature condition and attain development in the coelomic fluid. Each of them has a rounded head from 2 to 2.5μ in diameter and a short spinous process at its anterior end, (Fig. 12, Sp.) while at the other end there is a long tail of about 300μ to 400μ in length (Fig. 12. t).

When the reproductive cells are completely developed they make their way into the lumen of the brown tube. The exact way in which this is accomplished is not clear. But the old idea, that the internal opening has the power of selecting generative cells only, when they come within its reach while it rejects the coelomic corpuscles, is entirely erroneous. The coelomic corpuscles are clearly seen in the lumen of the nephridium though they are a few in number compared with reproductive cells. This paucity of the corpuscles may be due to their being disintegrated in the lumen of the nephridium.



Text fig. 12

With regard to the proportion of sexes in this animal, it is found that the number of females is predominantly large over the males. The proportion of males to females can roughly be stated as 1 : 60. This is not a phenomenon peculiar to this animal only. As will be seen from the following observations of previous workers, that the relative abundance of one sex over the other is also common in other Sipunculoids. For example Keferstein in 1862 noticed much disparity in the relative number of males and females of *Phascolosoma*. Only two individuals with spermatozoa were found among 200 specimens of females with eggs.

Claparede in the following year, found only one male in 112 females, and this one of a different species.

This disparity may be due to one of the following facts :

- (1) Animal may be male first and then become female throughout its life (Protandry).
- (2) Males may be extremely minute escaping observation.
- (3) There may be facultative parthenogenesis.

Owing to the extreme rarity of the male, it was found difficult to make any investigation with regard to the embryonic development of the animal.

Experiments on artificial fertilization are being made. The results are not as yet definite to be announced here.

List of theses which have been accepted in lieu of the Examination for the Degree of M.Sc. in Biological Sciences during the Year 1935-36

Subject	Title of thesis	Name of the candidate	Teacher	Place of research	Remarks.
Botany ...	A study of the Gametophyte of <i>Ophioglossum</i> from Poona.	Mr. T. S. Mahabale	Prof. D. L. Dixit	Fergusson College, Poona	
	The Nature and Bio-chemical action of the Fungus Flora of the Soil.	Mr. P. K. Anjaria	The Rev. G. Palacios S. J.	St. Xavier's College, Bombay	
	A contribution to the knowledge of the life history of <i>Naïas</i> <i>Graminea</i> Del.	Mr. C. M. Patel	Prof. S. V. Shevade	Baroda College, Baroda	
	The study of the periodical changes in the Hydrogen Ion concentration of the cell sap and in the Isoelectric point of the proteins of the cotton plant.	Mr. S. V. Mensinkai	Prof. R. H. Dastur	Royal Institute of Science, Bombay	
Zoology ...	The Structure and Bionomics of <i>Harpodon nehereus</i> (Ham. Buch.)	Mr. F. Max Pinto	Prof. P. R. Awati	Royal Institute of Science, Bombay	In preparation for publication.
	The Anatomy and physiology of the water-bug <i>Sphaerodema rusticum</i> Fabr.	Mr. M. J. Presswalla	Prof. C. J. George	Wilson College, Bombay	Published partly in this issue & partly in Proc. Ind. Acad. Sci., 11, pp 280-315

Reviews

Midwifery by Ten Teachers, under the direction of Clifford White.
Ed. by Sir Comys Berkeley, J. S. Fairbairn and Clifford White. Fifth edition. (Arnold & Co.) London, 1935. 18s. net.

The book has been admirably written for the student and proves without doubt of much practical use to him even afterwards in his practice. It is the fifth edition and no pains have been spared to bring information up to date especially about the functions of the anterior pituitary lobe and the ovary and their bearings on menstruation and pregnancy, about Aschheim-Zondek test and its utility in diagnosing Vesicular mole, about Toxaemia of pregnancy and puerperal sepsis. It is adequately illustrated, but to attain completeness some more figures are wanted on lower segment operation, described with classical Caesarian section, as it is often resorted to nowadays, especially in test labours; and the student will find it easy to understand its technic by the help of such illustrations. Again, there seems to be a mistake in naming different planes on Fig. 45, page 224. The plane of the anatomical outlet has been called 'the plane of least pelvic dimensions' and vice versa, an oversight which may be revised in the next edition.

In the management of face presentation, a description is given for converting the face into vertex. At the outset it has been mentioned, "such methods may do harm by precipitating rupture of the membranes.....the face presentation is likely to recur....." Yet a method is described, although in the following para, while summing up the position, it is mentioned 'though success is unlikely'. The description of such a doubtful and impracticable method may better be dropped. It will be to the advantage of the student from examination point of view.

In the treatment of eclampsia for the control of fits, opium up to two grains in twenty-four hours has been advised but it can be conceded that limitations have also been laid down. However, what has been found here is that whenever the drug is given more than one grain, even when the initial dose of morphia may be gr. $\frac{1}{4}$, the respirations are lowered seven or eight per minute and sometimes stopped and artificial respiration has to be resorted to and kept up for hours together. Even Dr. Fitz Gribbon has expressed

his views against such a big dose. Knowing the limit to be reached and forgetting the qualifications hedged round the administration of morphia, practitioners do in their dismay inject at short intervals morphia in order to bring fits under rapid control without waiting reasonably to see the effects produced by the initial doses. Again other drugs, such as Sodium Luminol by injection or Chloral Hydras per rectum, may be employed to supplement the effect of the effective dose of morphia, which avoids the dangerous influence of morphia on the respiratory centre and at the same time the fits can be controlled. So to err on the safe 'side and to prevent practitioners merely remembering the dangerous limit, which they recklessly rush to reach without using discretion, the dose advocated in such a standard text-book should not be more than a grain. Even Stroganoff does not advise more than $\frac{2}{3}$ gr. of morphia in 14 hours, given in combination with Chloral Hydras.

With all these minor points, as has been already mentioned, the book is the real text-book for the student, meeting his demands in all respects. It richly deserves the great popularity that it has rightly earned in the student world.

N. A. P.

Lectures on Diseases of Children by Robert Hutchison ; 7th Edition. (E. Arnold) London, 1936. 21s. net.

These lectures were delivered by the author to his students at the London Hospital. Even in cold print, they have still retained all the interest, information, lucidity and attractiveness that one invariably finds on hearing these learned discourses delivered by such an erudite scholar, acute observer and Clinician, and a refined lecturer. This Seventh Edition has been thoroughly overhauled and brought up to date. Perusal of this book would create sufficient interest in this important branch of medicine and the detailed discussion of treatment would be very valuable to the student and practitioner alike. The book has already established its well-merited popularity and good wine needs no bush.

B. G. V.

Text Book of Biology by E. R. Spratt and A. V. Spratt, published by Universal Tutorial Press, London, 9/6.

The authors have written this text-book of biology for the benefit of students completing their secondary education and preparing for Intermediate Science and Medical Entrance Examination of British Universities. Both the authors have taught the

subject for many years and treated it lucidly and exhaustively in this book.

They have arranged the treatment of plant and animal types so as to bring out how these two kinds are the outcome of the same life activity and how they live in associations for mutual advantage. A chapter is devoted to the chemical messengers of the animal body and the chapters on the physiology of plants and animals describe many simple illustrative experiments.

The value of the book would have, however, enhanced if the last chapter dealing with evolution, heredity etc. had been considerably increased.

S. H. L.

Books Received

1. *Farmaciones Sedimentarias de Patagonia* por Alfredo J. Torcelli, (Obras Completas Y Correspondencia Cientifica, Vol. XVI) La Plata, 1934.
2. *A list of Marine Algae from Bombay* by F. Borgesen with 10 plates (Biologiske Meddelelser, XII, 2), Kobenhaven, 1935.
3. *Midwifery by Ten Teachers under the direction of Clifford White*. Ed. by Sir Comyns Berkeley, J. S. Fairbairn and Clifford White. Fifth edition (Arnold & Co.) London 1935.
4. *Problems in Filariasis*, by T. Bhaskara Menon, (Maharaja of Travancore Curzon Lectures, 1934-35), Madras, 1935, Re. 1.
5. *El Tetraprothomo Y el diprothomo* por Alfredo J. Torcelli (Vol. XVII: Obras completas Y correspondencia cientifica) La Plata, 1934.
6. *Distribution of the Breeding Birds of Ohio* by Lawrence E. Hicks. (Ohio State Univ. Studies, XL, 5).
7. *Lectures on Diseases of Children* by Robert Hutchison (E. Arnold) London, 1936. 21s. net.

Acknowledgments

1. *Memoirs of the Faculty of Science and Agriculture.*
2. *Japanese Journal of Medical Sciences*—III. Biophysics.
3. *Ohia Journal of Science.*
4. *Bulletin of Hygiene.*
5. *Journal of the Indian Botanical Society.*
6. *Japanese Journal of Obstetrics & Gynaecology.*
7. *Indian Forest Records (Botany Series).*
8. *Twenty-fifth report of the Henry Phipps Institute for the study, treatment and prevention of tuberculosis, 1934.*
9. *Verlagen der Tuberculose studie-commissie van de Nederlandische centrale vesrenging tot bestrijding der Tuberculose, IX, 1935.*
10. *Records of the Malaria Survey of India.*
11. *Memories du Musee Royale d'Histoire Naturelle de Belgique, hors series.*
12. *Bulletin :* *do.*
13. *Proceedings of the Indian Academy of Sciences.*
14. *The Journal of the Indian Botanical Society.*
15. *Imperial Bureau of Plant Genetics,—Plant Breeding Abstracts.*
16. *Bombay Medical Journal.*
17. *Memoires of the College of Science, Kyoto Imperial University, Series B.*
18. *Science Reports of the Tokyo Bunrika Daigaku, Section B.*
19. *The Philippine Journal of Science.*
20. *Journal of the Bombay Natural History Society.*
21. *Medical Digest.*

22. *Annotationes Zoologicae Japonenses.*
23. *Memoirs of the Faculty of Science and Agriculture—Taihoku Imperial University.*
24. *Indian Journal of Venereal Diseases.*
25. *Lingan Science Journal.*

Exchanges

Academy of Sciences W-R-SSR, MINSK

Acta Geographica (Geographical Society of Finland, Helsingfors Finland.)

Andhra Historical Research Society, Rajamahendry.

Anthropos: International Zeitschrift für Volker- und Sprachenkunde,
Revue Internationale d'Ethnologie et de Linguistique, St. Gabriel-
Modling, (near Vienna) Austria.

Archiv Orientalni: Journal of the Czechoslovak Oriental Institute,
Prague.

Bhandarkar Oriental Research Institute, Poona.

Bibliothek Der Deutschen Morganländischen Gesellschaft, Friedrich
Str. 50A, Halle (Saale). Germany.

Bombay Branch of the Royal Asiatic Society, Town Hall,—Bombay.

†Bombay Medical Journal, Blavatsky Lodge Building, French Bridge,
Bombay, 7.

Bulletins of the Madras Government Museum, (Supd. Govt. Museum
and Principal Librarian, Connemara Public Library, Egmore,
Madras).

*Bureau of Chemical Abstracts (Central House, 46-47, Finsbury
Square, London, E. C. 2).

Bureau of Hygiene and Tropical Diseases, (Keppel Street, Gower
Street, London, W. C. 1).

Calcutta Mathematical Society (92, Upper Circular Road, Calcutta.)

*Chemical Abstracts (Published by the American Chemical Society—
Editorial Office: The Ohio State University, Columbus, Ohio,
U. S. A.)

*Chemisches Zentralblatt (Dr. M. Pflücke, Sigismundstrasse, 4,
Berlin, W. 10.)

Chief Librarian, Library of the R. Swedish Academy of Sciences,
Stockholm 50 (Sweden).

Colombo Museum, Colombo, Ceylon.

Dacca University Journal, Ramna, Dacca.

Department of Agriculture and Commerce, Scientific Library
Division, Manila, Philippine Islands.

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Director, Industrial Intelligence and Research Bureau, Simla.

Director, Malaria Survey of India, Kasauli.

Drama: Published by the British Drama League, Adelphi Terrace
London.

†Only No. 5.

*Only Nos. 2 and 4 (for the purpose of abstracts).

Ecole Francaise D'Extreme-Orient, Hanoi, Indo-China.

* * The Librarian, Cotton Research Station, Trinidad, B. W. I.

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General Editor, Indian Science Abstracts, 1, Park Street, Calcutta.

Hon. Secretary, Koninklijk Institut voor de Toal Land-en Volkarkunde, van Nederlandsch-Indies, Van Galenstraat, 14, Gravenhage.

Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.

‡Imperial University of Osaka, (The Dean, Faculty of Science).

Indian Culture : 43, Kailas Bose Street, Calcutta.

Indian Historical Quarterly : Edited by Dr. Narendra Nath Law, and published at Calcutta.

‡Indian Institute of Science, Bangalore.

Indian Journal of Medical Research, (Central Research Institute, Kasauli).

Institute of Ethnology, University of Vienna, Vienna.

International Cotton Bulletin : Published by the International Federation of Master Cotton Spinners' and Manufacturers' Association, Manchester, England.

International Review of Agriculture : (Secretary-General, Institute International d'Agriculture, Villa Umberto. 1-Rome (110) Italy.)

Institute of Mathematics, Osaka Imperial University, Osaka, Japan.

Journal of the Annamalai University, Annamalainagar, South India.

Journal of the Bihar and Orissa Historical Research Society, Patna.

Journal of the Faculty of Science, Hokkaido Imperial University, Sapporo, Japan.

Journal of Indian History, 'Sripadam,' 143 Brodies Road, Mylapore, Madras.

* *Journal of the Karnatak Historical Research Society*, Dharwar.

† *Journal of the Local Self-Government Institute*, Bombay.

Journal of the Royal Asiatic Society, 74, Grosvenor Street, London. W. 1.

Journal of the University of Madras, Madras.

**Only No. 5.

*Only Nos. 1, 4 and 5.

†All the issues except No. 2.

‡Nos. 2 and 5 only.

**Karnatak Historical Review* (Lingaraj College, Belgaum).

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[PART 6

ACCOUNT OF AN EXPLORATORY TOUR IN CERTAIN PARTS OF SIND IN SEARCH OF PRE-HISTORIC CULTURE.

The discoveries of the Archæological Department at the site of Mohen-jo-Daro have created enough interest in Sind for the ordinary people to speak about mounds known to them and generally to ascribe to them great antiquity. In January 1935 when I decided to visit Mohen-jo-Daro and certain other centres of ancient culture in Sind with one of my pupils, who was intending to write a thesis on the cultural history of Sind, I came to know that there were numerous mounds, not explored by the Archæological Department, on the Eastern bank of the Indus. Some of these mounds, I was told, were situated in the State of Khairpur. Having known that Mr. N. G. Majumdar of the Archæological Department, had explored during his tours only one important mound on the Eastern bank of the Indus, viz. the Chanhu-Daro in the Nawabshah District, I came to the conclusion that a survey of the reported mounds in Khairpur State was very important in view of the fact that they would be a considerable distance North of Chanhu-Daro and almost due East of Mohen-jo-Daro. After visiting Mohen-jo-Daro in February, I reached Khairpur and made further enquiries with a number of Officers of the State and also with H. H. the late Mir Saheb, who was deeply interested in the antiquities of his State. These enquiries convinced me of the

desirability of visiting the places that were mentioned to me during my enquiries. The Government of H. H. the Mir Saheb gave me facilities for my work for which I am very thankful to them. Of the four sites that I explored three have yielded unmistakable evidence of pre-historic culture while the fourth definitely belongs to the Buddhistic age. I have confined this account only to the three pre-historic sites.

NARU-JO-DHORO. Naru-jo-Dhoro is the name of a hamlet consisting of a few huts of Haris. It is supposed to have been named after a Hindu gentleman who lived there five generations ago. It is said of him that he owned large lands and built a well which forms the main water supply for the hamlet even to-day. Some river is supposed to have run by its side in olden times and the word 'Dhoro' * meaning 'hollow', 'river basin', supports the traditional account of a river running by the place. The legendary king Dularai who, as is well-known to students of Sind history, figures in connection with the ancient city of Arore is also connected with this place in the traditional story told about this mound. The mound is supposed to be the ruins of a city of that King. As in the story about Arore so in the one about this place the ruin of this city is ascribed to his traditional lust which in this story impelled him to demand the right of the first night with every newly wedded bride. There is also an alternative folk-tale which ascribes all this to a king named Nasha who in the sequel is identified with Dularai.

About two miles east of the Railway Station Tando Masti Khan there appear a number of sand-capped ridges extending over large area. Towards the south-eastern end of the range and in continuation with it lies the ridge which is called the mound of Naru-jo-Dhoro. It lies within a few yards of the beaten track that runs from Tando Masti Khan to Kot-Diji on its southern side and is about 7 miles north-west of Kot-Diji. This mound is distinguished from other sand-capped ridges by its reddish colour which it bears because of the pottery-pieces strewn about on its surface.

On reaching the place I could see the pottery pieces and later came across a few broken flakes of chert and flint. In the meanwhile one old villager informed us that somebody had excavated large earthenware pots from the western side of the mound. I got a few trenches dug with the help of the few labourers that I had

*In Kathiawar a mound is generally spoken of as a 'Timba' but at Vala I was informed it is also called by the villagers 'Dhoro'. At Cambay the word used is either 'Tenkra' or 'Dhado'—cf. Sindhi 'Tukkar' and 'Dado'.

there with me. Of the twelve small pits dug at various places five yielded no pottery whatsoever either whole or in pieces. The others yielded whole pottery, or pieces of pottery, or stone-implements within two to four feet from the surface. At one place the pit was dug to the depth of about seven feet but owing to the sand falling in I had to give up going deeper. Most of the pots were dug up in the west corner of the mound. The painted pottery-pieces, pl. VI, and bones of a bovine animal were found in the pit on the north-western slope. All the miniature pots, excepting one, pl. II No. 17, which was found in the pit on the north-western slope, were found in the western-most pit. The stone-implements, pl. XIV Nos. 7-14, were also found in these pits. The gold piece, which is not figured in the plates, and the largest earthenware pot figured in the plate, No. IV, and two of the shell-bangles, the larger ones, pl. VII, were found in one of the western-most pits. In another pit was found a greenish blue tubular stone-bead. In another pit in this corner were found the other shell bangles and the copper mirror, pl. XIV, 17. The pots excepting in one pit appeared to be lying *in situ*. Only in one pit, from which came the beautiful large vase, pl. III, No. 1, and other vases with red wash, the pots were lying in a heap. The fine small pot with high slender base, pl. II, 24, was found in the pit which was dug on the top of the mound almost at the centre. Almost in a straight line with this pit a few yards away on the north was found in a pit a human burial. The skeleton which was lying about three feet below the surface was very carefully laid and was rather longish, at least six feet in length. It lay on its back with the legs stretched almost due south and the hands lying stretched by the sides. The head and the chest were slightly raised above the line of the rest of the skeleton. The bones began to crumble when they were picked up. Only a few of the long bones and the parietal portion of the skull reached safe Bombay. Mr. G. M. Kurulkar, Associate Professor of Anatomy in the S. G. S. Medical College, Parel, who is studying the few bones that are intact, tells me that it was a male and that its height could not be less than six feet and was a mesaticephal. In some of the bones, he tells me, the process of fossilisation had definitely started. On making enquiries with the villagers I found that that place was not used at all as a burial place in recent times. Further the orientation of the burial—with feet lying due south—precludes the possibility of its being a Mohammedan burial. No distinctive pottery was found associated with this burial. In a pit dug in the North-east corner was found the pot No. 4 in pl. No. II, standing on a dish; and

embedded in the earth in it was found a fine smooth nummulitic stone about an inch in length.

Nowhere in the pits dug was there any evidence of walls or of bricks. All the stone-implements, excepting eight, were collected from the surface, the largest bulk of them being from the north-eastern slopes. A potter from Kot-Diji, whom I summoned for restoring some of the broken pots, professed his inability to do the same and told me that that type of pottery was not made now-a-days.

DIJIAJO DARO. The Daro is situated on a projected ledge of the Takkar on which is situated the Kot Diji fort. It lies about a quarter of a mile to the west of Kot Diji, and just at the north-west foot of the Kot (fort). The highest point is about 14 ft. from the level (two man-heights). Some of the stones used for the walls are too large for one to remove. It is much dug into by villagers for earth for making sun-dried bricks. Thus it is in a hopeless condition for scientific study. Pottery-pieces are lying all over the surface, evidently dug up by the villagers. There are also two types of burnt bricks in pieces lying about, evidently used for walls. None of the walls now standing and visible show any brick-work. Generally they appear to be made of stones with the interstices filled in with earth and sometimes also with rubble. In this rubble a number of pottery pieces are seen. It would appear from the volume of the earth that some of the walls were of earth only. There is evidence of at least two settlements one above the other. While noting this fact it must also be mentioned that according to the traditional story this site is supposed to have been the scene of an earthquake, which turned the habitations upside down. The Daro was far larger than it is at present as I am reliably informed that fairly recently a part of it was cut and cleared. Further I am positively assured that from the portion cleared they had gathered some large pots and inkpots of what is known as glazed 'Kashi' work. I have myself found only four pieces of glazed Kashi work figured in plate No. XVI.

The finds mainly consist of pieces of pottery with painted, incised or raised decoration, a few miniature pots, a few terra cotta toys, among which the pig deserves special mention, a baked earthenware skin-rubber, flake-tools and core-tools of chert and flint. One rather peculiar find which deserves special mention is a white cowrie shell from which the white portion is rubbed away at three different places. Whether it was used for medicinal or magical purposes is more than can be decided at this stage.*

*In my work at both the sites I was helped by two of my pupils, Messrs. U. T. Thakur and G. K. Sabnis.

HISBANI. A little more than three miles from Kot-Diji in its southwest direction there is a small hamlet called Hisbani. Nearby the village on its western and south-western sides there are a number of eminences some of them stony, others fully capped with sand and still others, which are strewn with pieces of pottery. About two furlongs to the north of this and just by the side of the road that leads from Kot-Diji to Theri Town there is a large piece of stony ground just a little raised above the level of the road. It was this latter site that was pointed out to me as the Takkar of Hasbani. On my preliminary visit to this site, I collected pieces of rough flake-tools and a few pieces of pottery. The next time I visited this place and began to scour the place thoroughly, I found only two important objects, one a baked earthen-ware spindle-whorl and another a very unique piece of pottery made in two uniform layers the outer one being polished red and the inner one black. I came across some villagers who had come there from the hamlet of Hisbani. I had almost despaired of getting anything more than what I had collected by way of flake-tools and pottery pieces when the villagers told me that the ruins of the real Kot (Fort) of Diji, who was the queen of the celebrated King Dularai, lay very near their hamlet on the south-west side. These are the mounds that are referred to in this account at the outset. They are very extensive and literally strewn with pottery-pieces. I ransacked the whole for about two hours and my search was rewarded with some finds, particularly a decorated bead of flesh coloured carnelian, pieces of pottery, with painted designs in black on red background, and others with incised designs, and three stones, pl. XIX 4, 5 and 6. These stones appear to be some kind of implements shaped by means of grinding and polishing. They are of silicious lime-stone. Of the pieces of painted pottery one deserves special mention because it is the only one that I have come across in all my collection bearing an animal design, viz. that of the peacock, pl. XVIII. Towards the eastern end of the mound there was a place which was marked off by rough hewn stones arranged in a rectangle. I got a pit dug there to the depth of about four feet but I came across nothing except a piece of boar's tusk which seems to have been used for some purpose. It is figured in plate XVIII.*

ORANGI. The site of Orangi has already been described by Mr. Majumdar in his "Explorations in Sind". I visited it on two mornings. I need only add that the site seems to be far more

* I was told that there were similar mounds at Mirwah, Dalore and Kandiaro but I had no time to visit these sites.

extensive than the description given by Mr. Majumdar would lead one to believe. On the area which is directly approached from the landing near the Local Board watering place I picked up a few pieces of stone out of which two deserve special mention. One is a curved core-tool almost black in colour and is illustrated in the line drawings B. The other is even more important. It is an axe broken at the butt-end made out of granite-like stone. It is clearly of Neolithic workmanship, pl. XIV, No. 27.*

It will be seen from the plates and the descriptive lists that the various objects found at Naru-jo-Dhoro and Kot-Diji, from the shapes of pots to the knobbed wheels of toy-carts, from the triangular bricks to the small flat rings used as ornamentations, or as charms, the finds have the clearest affinity with the Mohen-jo-Daro culture. Almost all the pots found at Naru-jo-Dhoro, excepting one figured in plate I, No. 10, and not excepting even the miniature pots were turned on the wheel. The ringed bases of the few pots seem to have been separately made and then joined on to the main body. The pots are almost all uniformly baked. Whether they were baked in a kiln or not cannot perhaps be decided now. But in contradiction of what Dr. Makay has said about the firing of pots today in Sind, I must point out that I saw built-up kilns for the purpose of firing pots both at Hala and Sehwan, the two places most noted in Sind for their glazed pottery, though at Larkhana I saw that pots were baked in the open. Hisbani pottery-pieces, on the other hand, reveal by their designs perhaps a later age. Orangi, whatever else it might be, clearly was also a Neolithic settlement. It may be pointed out in this connection that for the solution of some of the problems raised by the discovery of the Indus Valley culture, far more ample finds of pottery, associated with Neolithic artefacts are necessary.

* At Hisbani and Orangi Mr. G. K. Sabnis was working with me.

Plate I

<i>Narujō-Dhoro</i>		<i>Height.</i>	<i>Width at the mouth.</i>
(1)	Jar with round mouth, dull red colour.	0 - 8 "	$3\frac{1}{2}"$;
(2)	Jar with round mouth, broken at the top, dull white colour.	0 - $11\frac{1}{4}"$	$3\frac{1}{2}"$
(3)	Jar with well-marked neck and wide mouth.	0 - $6\frac{3}{4}"$	$3\frac{1}{4}"$
(4)	Jar with slightly marked neck and round mouth.	0 - $4\frac{1}{2}"$	$2\frac{1}{2}"$
(5)	Jar with bulging and narrowed neck; upper half, upside down.	0 - 8 "	$3\frac{3}{4}"$
(6)	Jar with narrow mouth slightly broken, red colour.	0 - 11 "	4 "
(7)	Jar with wide mouth; dull white colour slip.	0 - $8\frac{3}{4}"$	$3\frac{1}{2}"$
(8)	Jar with wide round mouth.	0 - $8\frac{1}{4}"$	$3\frac{1}{4}"$
(9)	Jar with wide longish neck with rim broken, dull white colour slip.	0 - $7\frac{1}{2}"$	3 "
(10)	Lota with high neck, wide mouth and high base.	0 - $5\frac{1}{4}"$	$3\frac{1}{4}"$
(11)	Vase with broad mouth; dull white colour slip.	0 - $5\frac{3}{4}"$	$3\frac{1}{4}"$
(12)	Lota similar to No. 10; dull white colour slip.	0 - $5\frac{3}{4}"$	$3\frac{1}{2}"$
(13)	Lota similar to No. 10; dull white colour slip.	0 - 6 "	4 "
(14)	Wide-mouthed lota, dull white colour slip.	0 - 4 "	$3\frac{1}{2}"$
(15)	Vase (flower) narrow and with broad mouth and high base; red colour wash.	0 - $6\frac{1}{2}"$	$3\frac{1}{4}"$
(16)	Vase with broad mouth and narrow rimmed pedestal; dull white.	0 - 11 "	5 "
(17)	Jar with narrow rimmed pedestal, low neck, red wash and having black lines round the body.	0 - $8\frac{3}{4}"$	$3\frac{1}{2}"$
(18)	Jar with narrow pedestal, long neck, top broken; dull red wash.	0 - $10\frac{3}{4}"$	$3\frac{3}{4}"$
(19)	Jar with narrow rimmed pedestal and without neck; dull red wash.	0 - $7\frac{3}{4}"$	4 "

Plate II

<i>Narugo Dhoro</i>		<i>Width</i>	
		<i>Height.</i>	<i>at the mouth.</i>
(1) Jar medium, resembling a brass pot with wide mouth; buff colour.	0	- 7 $\frac{3}{4}$ "	5 $\frac{1}{4}$ "
(2) Small pot, buff colour.	0	- 4 "	2 $\frac{3}{4}$ "
(3) Jar with small base and wide mouth; buff colour.	0	- 8 $\frac{1}{4}$ "	5 $\frac{1}{4}$ "
(4) Jar with small base not well shaped; buff colour.	0	- 10 $\frac{1}{2}$ "	5 $\frac{1}{2}$ "
(5) Big jar with small base, complete; buff colour.	1'	- 3 "	7 $\frac{3}{4}$ "
(6) Small pot; buff colour.	0	- 5 $\frac{1}{4}$ "	3 $\frac{3}{4}$ "
(7) Small pot with small high base almost in pieces; reddish.	0	- 5 $\frac{1}{4}$ "	4 $\frac{1}{2}$ "
(8) Jar, 'Gadu'-like, lower side broken, well marked neck, upside down; painted red.	0	- 6 $\frac{1}{2}$ "	4 "
(9) Stand with narrow middle, ringed base, upper portion broken; buff colour.	0	- 8 "	8 $\frac{1}{4}$ " (base)
(10) Stand with very narrow middle, very wide base, screw like corrugation from inside, top broken; reddish.	0	- 9 "	9 $\frac{3}{4}$ " (base)
(11) Vase with high pedestal and round mouth; red wash.	0	- 11 $\frac{3}{4}$ "	4 $\frac{1}{4}$ "
(12) Jar neat finish; dull white.	0	- 7 "	4 "
(13) Pot with small base; reddish.	0	- 6 $\frac{1}{2}$ "	4 "
(14) Pot irregularly shaped; dull white.	0	- 5 $\frac{1}{4}$ "	3 $\frac{1}{2}$ "
(15) Bowl with very wide mouth.	0	- 3 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "
(16) Pot with small base finely shaped.	0	- 3 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "
(17) Miniature Jar-shaped vase with lid; blackish.	0	- 2 $\frac{1}{2}$ "	1 $\frac{1}{2}$ "
(18) Miniature Jar wide mouth and broad bottom; reddish.	0	- 1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "
(19) Miniature Jar; reddish.	0	- 1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "
(20) Miniature Jar with small well-marked base.	0	- 1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ "
(21) Miniature Jar-shaped Vase with lid; whitish.	0	- 3 $\frac{1}{2}$ "	1 $\frac{3}{4}$ "
(22) Miniature low Jar, tub-shaped.	0	- 1 $\frac{1}{2}$ "	2 "
(23) Miniature Jar slightly irregular.	0	- 1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "
(24) Pot with high narrow stand, upper rim broken, red wash, fairly thin and very well-made.	0	- 3 $\frac{1}{2}$ "	2 $\frac{1}{4}$ "

Plate III

	<i>Narujō-Dhoro</i>	<i>Height</i>	<i>Width at the mouth.</i>
(1)	Vase well shaped, painted red; ringed stand and mouth.	1' - 2 $\frac{1}{4}$ "	4 $\frac{1}{4}$ "
(2)	Jar, medium size, crude shape; dull white.	1' - $\frac{1}{4}$ "	6 $\frac{1}{4}$ "
(3)	Vase base broken, neatly worked; dull white slip.	0 - 11"	5"
(4)	Pot with small base, top broken, red wash.	0 - 4" (mouth broken)	
(5)	Jar with round mouth.	0 - 9"	3 $\frac{1}{2}$ "
(6)	3rd of the 1st Plate repeated.		
(7)	4th of the 1st Plate repeated.		
(8)	Vase, shaped like the neck of Surai, dull white wash.	0 - 7"	3 $\frac{1}{2}$ "
(9)	Pot very thin made of very fine clay; dull red colour (<i>from Kot-Diji</i>).	0 - 6"	3 $\frac{1}{2}$ "
(10)	Jar with broad mouth.	0 - 5 $\frac{3}{4}$ "	4"
(11)	Pot with high neck; dull white.	0 - 4 $\frac{1}{2}$ "	3 $\frac{1}{4}$ "
(12)	Pot with small raised base.	0 - 4 $\frac{1}{4}$ "	2 $\frac{3}{4}$ "

Plate IV*Narujō-Dhoro*

- | | | | |
|-----|---|-----------------------|-------------------|
| (1) | Big jar, little broken at the top and slightly protruding base. | 1' - 6" | 8 $\frac{1}{2}$ " |
| (2) | Chatty meant as lid of a Jar. | 0 - 2 $\frac{1}{2}$ " | 8 $\frac{1}{2}$ " |

Kot-Diji

- (3)-(10) Balls of white stone of different sizes and weights meant as weights biggest diameter 0 - 2 $\frac{1}{2}$ " and smallest diameter 0 - 1"; Tolas 1, 2, 3, 5, 7 $\frac{1}{2}$, 10, 20, 25, 30 each.
- (11)-(12) Triangular terra-cotta tablets meant as weights (?); (i) 3 $\frac{1}{2}$ " \times 3 $\frac{1}{2}$ " \times 3 $\frac{1}{2}$ "; (ii) 2 $\frac{3}{4}$ " \times 2 $\frac{3}{4}$ " \times 2 $\frac{3}{4}$ "; (iii) 2 $\frac{1}{4}$ " \times 2 $\frac{1}{4}$ " \times 2 $\frac{1}{4}$ ";
- | | | |
|------|---|--------|
| (13) | Miniature double Vase, top slightly broken, dull red; height | 0 - 3" |
| (14) | Similar to (3) - (10). | |
| (15) | Similar to (3) - (10) with hole bored in it (mace head?). | |
| (16) | Cowri shell rubbed on the top and the two sides; almost all the white substance is rubbed off at the three spots. | |

Plate V*Kot-Diji*

- Nos. 1-32 Sherds from Kot-Diji with different colours and designs for ornamentation.
- Nos. 1-7 have straight, curved and wavy lines as decorations.
- Nos. 8-12 have bead-like pendants added to the lines.
- Nos. 14-18 have designs of intersecting circles with hatched and filled lozenges.
- Nos. 20-22 have fish-scale patterns.
- Nos. 26, 27, 29 have 'pippal'-leaf decoration.
- No. 30 has complex branch design.
- Nos. 25, 31, 32 have leafy designs.
- No. 23. Sun, star or some eye designs.
- No. 24 same with complication.
- No. 28 some geometric design—in three colours—cream, deep-red and black.

These designs and decorations are all painted with black colour on black-ground which is painted red, slightly different in shades and fastness.

Plate VI*Narujō-Dhoro*

- Nos. 1-3 are broken pieces of the neck of pots.
- No. 5. Painted piece of pot, well moulded neck, dark red ground designs in black.
- Nos. 4-7. Sherds having fish-scale design on the belly and star or sun design on the shoulder.
- Nos. 8-13. Sherds with faint traces of ornamentations.
- Nos. 14, 18 & 19. Sherds with etched designs on them.
- No. 15. Sherd with a hole-depression.
- Nos. 16-17. Triangular pottery weights (?).
- Nos. 21-22. Sherds perforated
- Nos. 23, 24, 30, 32 bases of pots and bowls.
- No. 25. Baked earthen object for grinding (?).
- Nos. 26-28. Pieces of pottery bangles.
- No. 27. may be anklet or armlet.
- No. 29. Piece of a toy cart base with three holes.

Plate VII*Narujō-Dhoro*

- (1) Terra cotta wheel with knob and hole in the centre, dull red.

Diameter 0 - 2 $\frac{3}{4}$ "

- (2) Terra cotta wheel half piece with hole groove, dull red. Diameter 0 - $2\frac{1}{2}$ "
- (3) Terra cotta ball meant for weighing (?) reddish. „ 0 - $1\frac{1}{2}$ "
- (4) Portion of terra cotta toy cart base with two holes and part of piece at right angles to it, dull red. Length 0 - $3\frac{1}{4}$ "
- (5) Pottery piece; neck of pot with fast red colour. Height 0 - 2"
- Cf. Pls. 96 & 97 of Marshall's 'Mohenjo-Daro' {
- (6) Terra cotta piece of toy with holes. Length 0 - $1\frac{1}{2}$ "
- (7) Terra cotta head of an animal with holes for string. „ 0 - 1"
- (8) Pottery piece, thin neck of a pot with fast red colour. Height 0 - 2"
- (9) Pottery piece, thin neck of a pot with fast red colour smoothly worked. „ 0 - $1\frac{1}{2}$ "
- (10) Terra cotta piece of toy cart with one hole in horizontal section. Length 0 - $2\frac{1}{8}$ "
- (11-12) Small perforated pieces of ivory.
- (13) Stone-bead - greenish blue in colour. Cylindrical.
- (14-15) Shell pendants, (for the year ?) one of them has a small hole in the narrow top-ridge.
- (16) Shell Bangles. Diameter 0 - 4"
- (17) Shell Bangles.
- (18) Pottery dish with indentations on the bottom. „ 0 - $6\frac{1}{4}$ "
- (19) Terra cotta cup with perforated lug handle, light red, well shaped. Height 0 - $1\frac{3}{4}$ "
- (20) Terra cotta cup with perforated lug handle light red. „ 0 - $2\frac{1}{2}$ "
- (21) Terra cotta dish in fragments. Diameter 1' - 1"
- (22) Terra cotta dish in fragments. „ 1' - $0\frac{1}{2}$ "
- (23) Core.
- (24) Broken flake.
- (25) Terra cotta dish. Diameter 0 - 11"
- (26) Terra cotta dish. „ 1' - $1\frac{1}{2}$ "
- (27-30) Flints—first being pointed and bent at the end for engraving. (?)

Plate VIII*Kot-Diji*

- | | |
|--|--------------------------------|
| 1. Bowl (broken) with red wash inside and on the base. | Diameter 0 - 5" |
| 2. Miniature tumbler, edge broken, regular pairings with knife. | Height 0 - 2 $\frac{1}{4}$ " |
| 3. Portion of a wheel with a hole in the centre slightly convex. | Diameter 0 - 4 $\frac{1}{4}$ " |
| 4. Miniature Jar, side broken, neatly worked, dull white. | Height 0 - 1 $\frac{3}{4}$ " |
| 5. Miniature Vase with small high base, mouth broken, red wash. | „ 0 - 3" |
| 6. Lower portion of a pot whitish, mouth broken. | „ 0 - 2 $\frac{1}{2}$ " |
| 7. Miniature Jar-like pot with red slip belt on the neck. | „ 0 - 1" |
| 8. Wheel with a small hole in the centre and even surface. | Diameter 0 - 2 $\frac{1}{2}$ " |
| 9. Lid of No. 7 with pointed catch. | „ 0 - 0 $\frac{3}{4}$ " |
| 10. Lid (of Jar etc.) with knob broken. | „ 0 - 2" |

Plate IX*Kot-Diji*

- | | |
|--|------------------------------|
| 1. Miniature pot with high narrow base and red line ornamentation. | Height 0 - 3 $\frac{1}{4}$ " |
| 2. Miniature pot with high narrow base, broad mouth and black dot ornamentation. | „ 0 - 1 $\frac{3}{4}$ " |
| 3. Miniature pot with high neck and low base, partly broken. | „ 0 - 2 $\frac{1}{4}$ " |
| 4. Terra cotta irregular ball (meant for hammering) with depression on both sides. | Length 0 - 4 $\frac{1}{2}$ " |
| 5. Circular stone disc. | Diameter 0 - 3 " |
| 6. Blackish stone (baetyl?). | Height 0 - 3 " |
| 7. Stone ball, pear-shaped, whitish with grooved depression on the conical top. | „ 0 - 3 " |
| 8. Hammer-stone (?). | „ 0 - 5 " |
| 10. Black very smooth stone. | „ 0 - 5 " |
- 9 & 11-14. Cores and implements.

Plate X*Kot-Diji*

- | | |
|--------------------------------------|--------------|
| (1) Terra Cotta animal toy (swine?). | Length 0 - 4 |
| (2) Neck portion of a pot. | |

- | | | |
|--|----------|-----------------------|
| (3) Terra cotta hen with stand and hole at the back for feathers. | Height | 0 - 2 $\frac{3}{4}$ " |
| (4) Terra cotta toy, ram. | Length | 0 - 3 " |
| (5) Sherd with neck portion. | | |
| (6) Deer horn with the stem; might have been used as an implement. | | |
| (7) Terra cotta toy, humped bull. | Length | 0 - 3 " |
| (8-9) Sherds: neck portions. | | |
| (10) Complete pottery bangles: three in number. | | |
| (11) Three pieces of flat bone—(some implements?). | | |
| (12) Sherd: bottom portion. | | |
| (13-19) Sherds with rim portions. | | |
| (14) Deer horn. | Length | 0 - 3 $\frac{1}{2}$ " |
| (15) Pottery beads of different sizes and with different ornamentations over them. | | |
| (16) Piece of a shell bangle. | | |
| (17) Pottery bead long variety— $\frac{1}{2}$ portion of a whole, the broken end being on the reader's left. | | |
| (18) Thin white rings of ivory with holes used as charms or ornaments (?) | Diameter | 1/5" to .55" |

Plate XI

Kot-Diji

- | | | |
|---|----------|-----------------------|
| 1. Neck of a pot with light dark colour outside and inside up to the neck. | Height | 0 - 2 " |
| 2. Sherd with fast red wash, thin variety. | Height | 0 - 4 " |
| 3. Sherd neck portion. | | |
| 4. Sherd, bottom portion. | | |
| 5. Base of a pot, dull red. | Diameter | 0 - 1 $\frac{1}{2}$ " |
| 6. Sherd middle portion of a pot red wash, thinner at the neck. | Height | 0 - 2 $\frac{1}{2}$ " |
| 7. Base of a pot or a bowl red wash with depression in the bottom. | Diameter | 0 - 2 " |
| 8. Sherd, neck portion with double line decoration and three potter's marks (incised) like cross, on the rim. | Height | 0 - 3 " |
| 9. Lower portion of a pot with complete base. | „ | 0 - 1 $\frac{1}{2}$ " |
| 10. Base of a pot: fast red colour wash. | „ | 0 - 1 " |
| 11. Middle portion of a pot, red wash, thin variety. | „ | 0 - 2 " |

- | | | | |
|-----|--|--------------|---------|
| 12. | Pottery object with a slight knob in the centre. | Diameter | 0 - 3 " |
| | | Top Diameter | 0 - 0½" |
| 13. | Lid with a hole in it very thin, red colour wash. | " | 0 - 1½" |
| 14. | Lower portion of a pot with narrow base, darkish colour. | Height | 0 - 1¼" |
| 15. | Sherd. | | |
| 16. | Lower portion of a pot with hand-made bottom and base. | " | 0 - 2½" |

Plate XII

Kot-Diji

- Nos. 1-4) and 12-18 Sherds with colour wash and line decoration.
- Nos. 5-11 Sherds with perforations meant as heaters (?).
It is clear from No. 7 that the pots were perforated even in their bottoms.
- Nos. 19-20 Sherds with beads decoration.
- Nos. 21-22 Sherds with etchings.
- No. 23. Sherd with lines and wavy line decorations.
- Nos. 24, 26, 27. Sherds with the raised concentric circle decorations.
- No. 25 Piece of dish with thick rim and raised curvilinear decoration.
- Nos. 28-29 Sherds with raised concentric circles and dots between, representing the Sun (?).
- No. 30. Sherd with raised star decoration.
- No. 31. Sherd with raised ball decoration.
- No. 32. Lower portion of a Kundi (flower pot) like pot.
- No. 33. Pottery quern.
- Nos. 34, 35. Cones with holes in the bottom.
- No. 36. Half portion of a hollow pottery object, with protuberance in the interior.
- No. 37. Hollow pottery object, bearing slight traces of red wash. It is standing on the closed end. It is like the objects described as flesh rubbers in the Mohenjodaro finds. Length 0 - 10½"
- No. 38. Portion of terra cotta Circumference 0 - 10¾" knobbed wheel.
- Nos. 39-41. Pieces of pottery bangles.
- No. 42. Terra cotta wheel.

Plate XIII

No. 1-64 Flint flakes of different sizes and shapes. Majority of them have blunt ends due to wear and tear. Almost all of them are of dull white or cream colour; mostly of chert and flint. No. 545 of agate. Nos. 1-9, 11-30, 34-43 are from Kot-Diji. The rest are from Narujo-Dhoro.

Nos. Length. Breadth at base. Thickness at the bottom,

22	3 $\frac{7}{8}$ "	3"
26	3 $\frac{1}{4}$ "	1"
37	3 $\frac{3}{8}$ "	1"
38	4 $\frac{3}{8}$ "	1"
43	4 $\frac{1}{2}$ "	2"

Breadth greatest

5	1 $\frac{3}{4}$ "	1"	1"
16	1 $\frac{5}{8}$ "	1 $\frac{1}{4}$ "	1"
23	3 $\frac{1}{4}$ "	1"	1"
48	3"	3"	1"
50	3 $\frac{3}{4}$ "	1 $\frac{1}{4}$ "	1"

Thickness at bottom No. of flakes taken off

10	1 $\frac{1}{8}$ "	3"	13
31	3"	1 $\frac{6}{8}$ "	10
32	3"	1 $\frac{1}{4}$ "	11

Plate XIV

Naruj-Dhoro

Nos. 1-12 } are flint flakes of the type illustrated on Plate XIII.
Nos. 14-16 }

No. 13 is a core stone with many small facets (9).

Nos. 17 a copper mirror covered with verdigris.

Height 0 - 4 $\frac{1}{8}$ "

Breadth 0 - 2 $\frac{1}{2}$ "

	Length	Breadth	Thickness
1	1 $\frac{3}{4}$ "	1"	1"
2	1 $\frac{1}{4}$ "	1 $\frac{1}{4}$ "	1"
7	1 $\frac{3}{4}$ "	1"	1"
8	2 $\frac{1}{4}$ "	1"	1"
9	1 $\frac{3}{4}$ "	1"	1"
10	2"	1"	1"
11	1 $\frac{1}{2}$ "	1"	1"
12	1 $\frac{1}{8}$ "	1"	1"
13	1"	1"	1"
14	1"	1"	1"
15	0"	1 $\frac{3}{4}$ "	1"

It is chipped flat at the end.

Nos. 18-23.	Vases of different shapes and sizes, broken at the mouth.	Heights 18, 0 - 6" 19, 0 - 6" 20, 0 - 6½" 21, 0 - 5¼" 22, 0 - 6½" 23, 0 - 5"
Nos. 24-25	Portions of stands.	
No. 26	Bowl with narrow base (incenser ?). <i>Orangi.</i>	Height 0 - 3¼"
No. 27	Axe of lime-stone.	„ 0 - 4¼" Breadth 0 - 3¼"
<i>last row</i> (1)	Hammer-stone broken.	Length 0 - 3½"
(2)	Upper portion of an axe (?).	„ 0 - 2½"
(3)& (4)	Polishers oval and circular, yellowish.	
(5)	Hammerstone with drill marks on both sides.	Length 0 - 5½"
The small flints are illustrated by means of line-drawings at the end. (See A & B).		

Plate XV

Kot-Diji

(except No. 13 which is from Narujo-Dhoro)

	<i>Length.</i>	<i>Breadth.</i>	<i>No. of flakes taken off.</i>
1	1¼"	½"	16
2	1½"	½"	11
3	2 "	1¼"	21
4	2¾"	¾"	15
5	1½"	1 "	18
6	2 "	½"	13
7	2½"	½"	11
8	2¼"	¾"	10
9	2½"	¾"	10
10 Lancet.	1 "	—	—
11	2 "	1 "	11
12	1¾"	¾"	12
Thickness at base			
14	2½"	¾"	18"
15	1¾"	18"	18"
16	2¼"	18"	18"
17	1¾"	18"	18"

Plate XVI*Kot-Diji.*

No. 1-3 & 5-9. Big pieces of flint from which flakes have been chipped off. Some of them appear to be meant also for rough use as they are shaped at both ends, (pointed at one end and flat at the other).

No. 9 is of dull yellow colour, and is a polisher; a number of flakes have been struck off from the other side.

	<i>Length.</i>	<i>Breadth at base.</i>	<i>No. of flakes taken off.</i>
No. 1	0 - 6 "	$\frac{5}{8}$ "	13
No. 2	0 - 4 $\frac{3}{4}$ "	1 $\frac{1}{2}$ "	13
No. 3	0 - 3 "	1 "	13
No. 4	0 - 2 "	—	—
No. 5	0 - 4 $\frac{3}{4}$ "	1 "	13
No. 6	0 - 3 $\frac{1}{4}$ "	—	9
No. 7	0 - 2 "	—	11
No. 8	0 - 5 "	$\frac{3}{8}$ "	10
No. 9	0 - 3 "	—	—

Nos. 10-13 Pieces of Kashi (glazed) pottery—greenish blue glaze.

Plate XVII*Narujō-Dhoro.*

Flint flakes of different sizes and shapes of dull white colour. There are several curved specimens and several engravers. Some are irregularly shaped. They average from 0 - 1" to 0 - 3". The one by itself in the centre seems to have been a spear or lanced head.

Plate XVIII*Hisbani.*

Pottery pieces with beautiful raised and painted (black) designs in decorations.

Sun, beads and concentric circle decorations are very prominent. Two of them have grain-seed decorations.

Lower ones have line and points decorations, one of which has an eye decoration.

Of the five small objects in the black ground, three are spouts, the enlarged one showing the method of attachment.

The object, placed longitudinally, is either a bead or a spindle whorl of baked clay, dark red in colour.

The curved object is a worked piece of boar's tusk.

Of the two objects in the white ground the round one is a pottery bead and the other is a unique piece of pottery. It is in two, more or less uniform layers, black from inside and polished red on the outside.

The pot-sherd with painted peacock design deserves special attention as being the only piece in the whole collection with an animal design.

Plate XIX

Hisbani

- | | |
|--|------------------------------|
| (1) Neck of a pot with reddish lines inside the rim. | Height 0 - 2 $\frac{1}{8}$ " |
| (2) Pottery object (trunk of an elephant?). | „ 0 - 4" |
| (3) Hard baked pottery object (sort of an implement?). | „ 0 - 4 $\frac{1}{2}$ " |
| (4) Yellowish limestone polisher. | Length 0 - 3" |
| (5) Yellowish limestone polisher. | „ 0 - 2 $\frac{1}{4}$ " |
| (6) Yellowish limestone graver(?). | „ 0 - 4 $\frac{1}{4}$ " |

In three rows are small flint-flakes used as implements excepting the three objects in the middle of the first row. Majority of them are roughly worked.

(Not figured)

- (1) Gold piece (Narujo-Dhoro) :—
About $\frac{3}{4}$ " long $\frac{1}{8}$ " broad thin plate of gold with four holes—one at each end and two together in the middle.
- (2) Carnelian bead (Hisbani) :—
 $\frac{3}{8}$ " x $\frac{3}{8}$ " with black lines intersecting diagonally. It is $\frac{1}{8}$ " thick with a hole bored in the middle lengthwise for the thread to pass. There is a line all round the border on both sides.



PLATE I

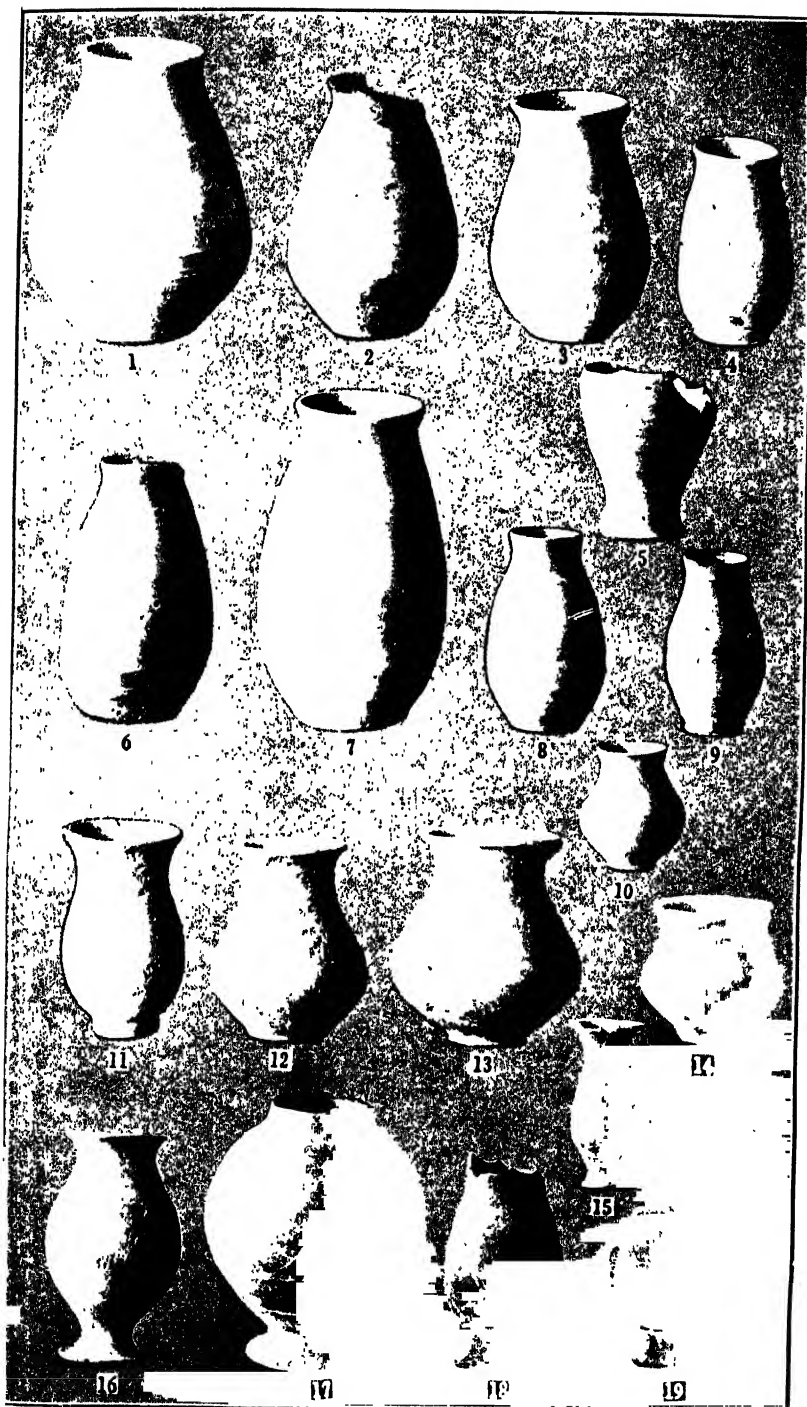


PLATE II

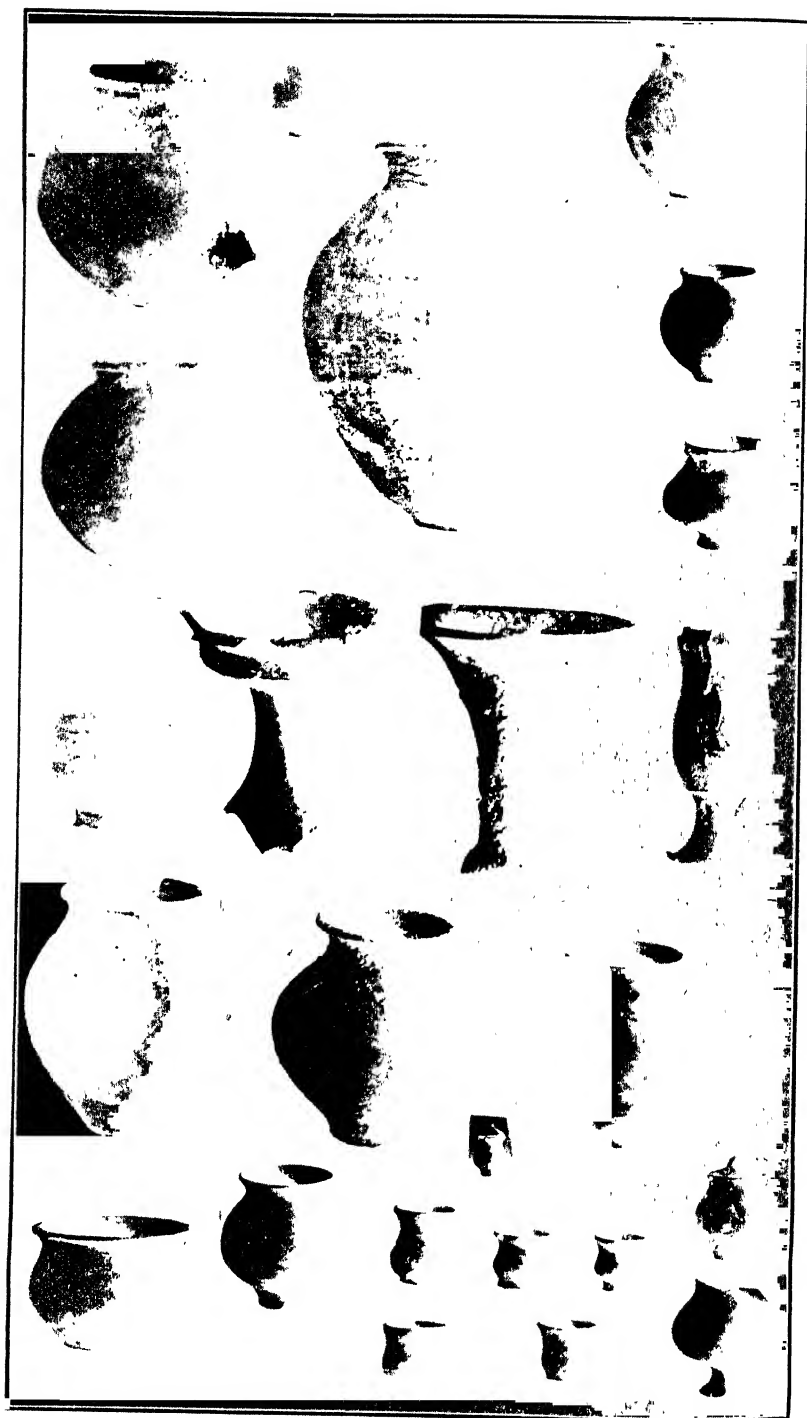


PLATE III

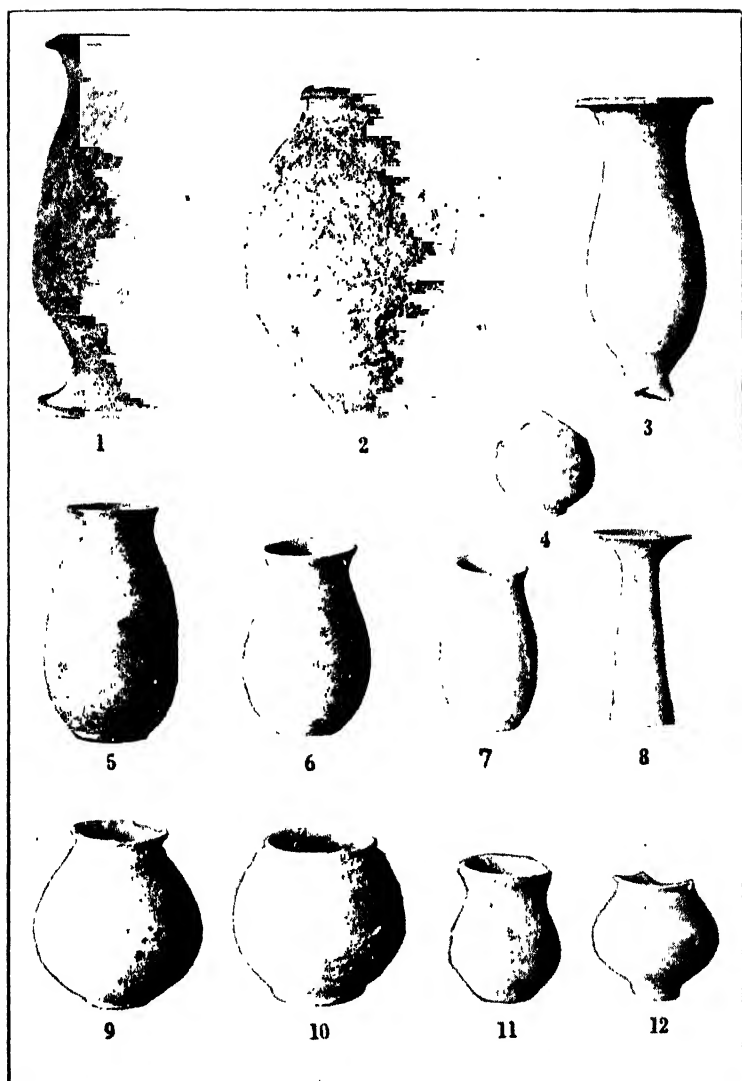


PLATE IV



PLATE V

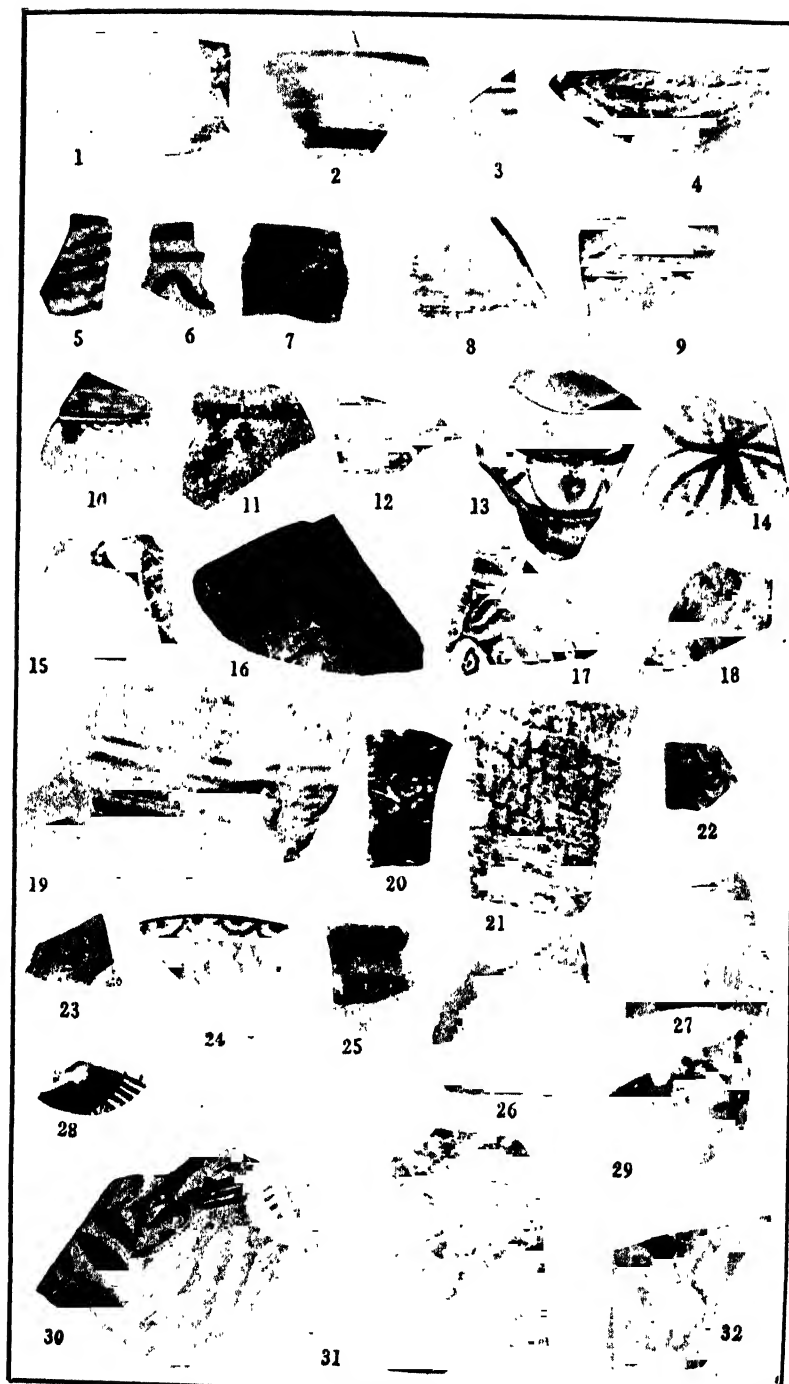


PLATE VI



PLATE VII

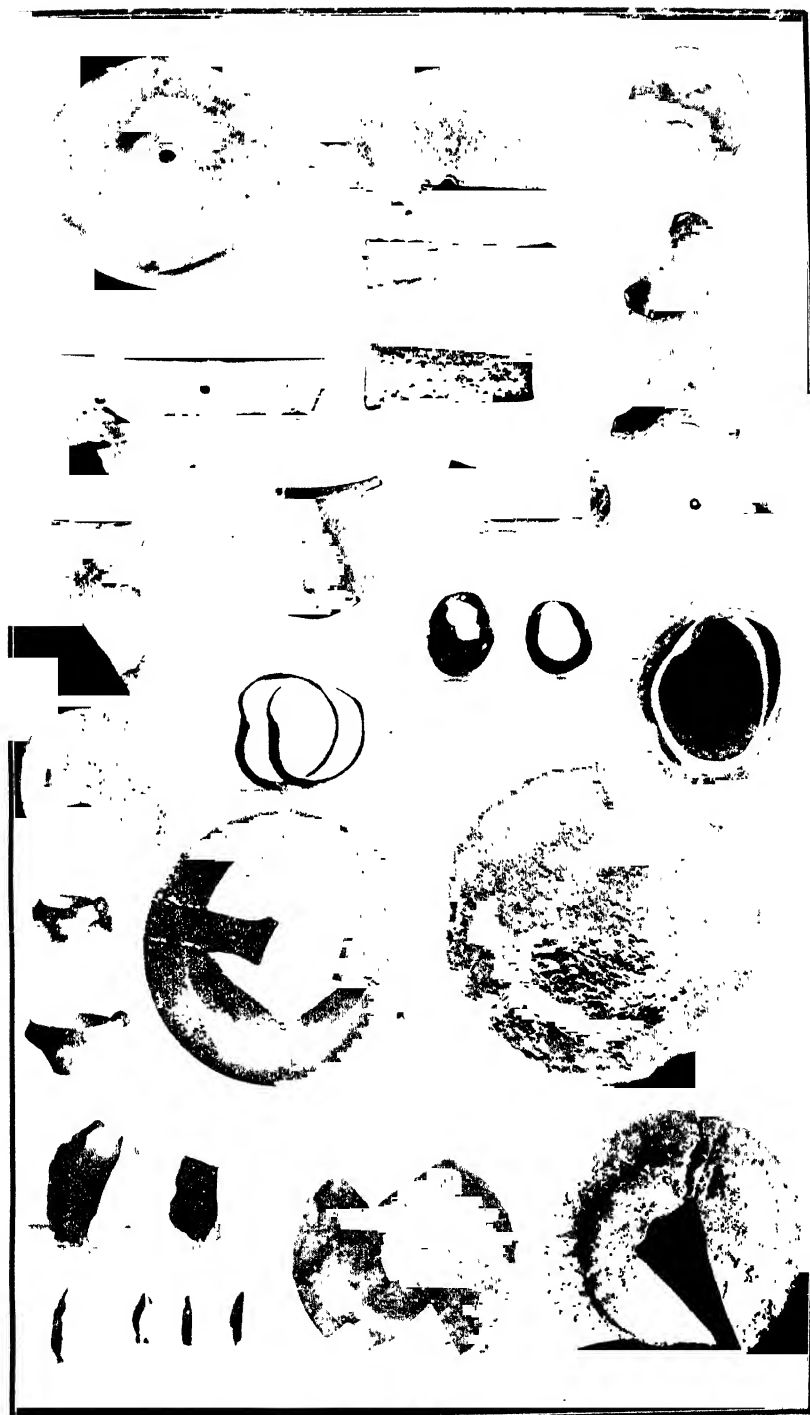


PLATE VIII



PLATE IX

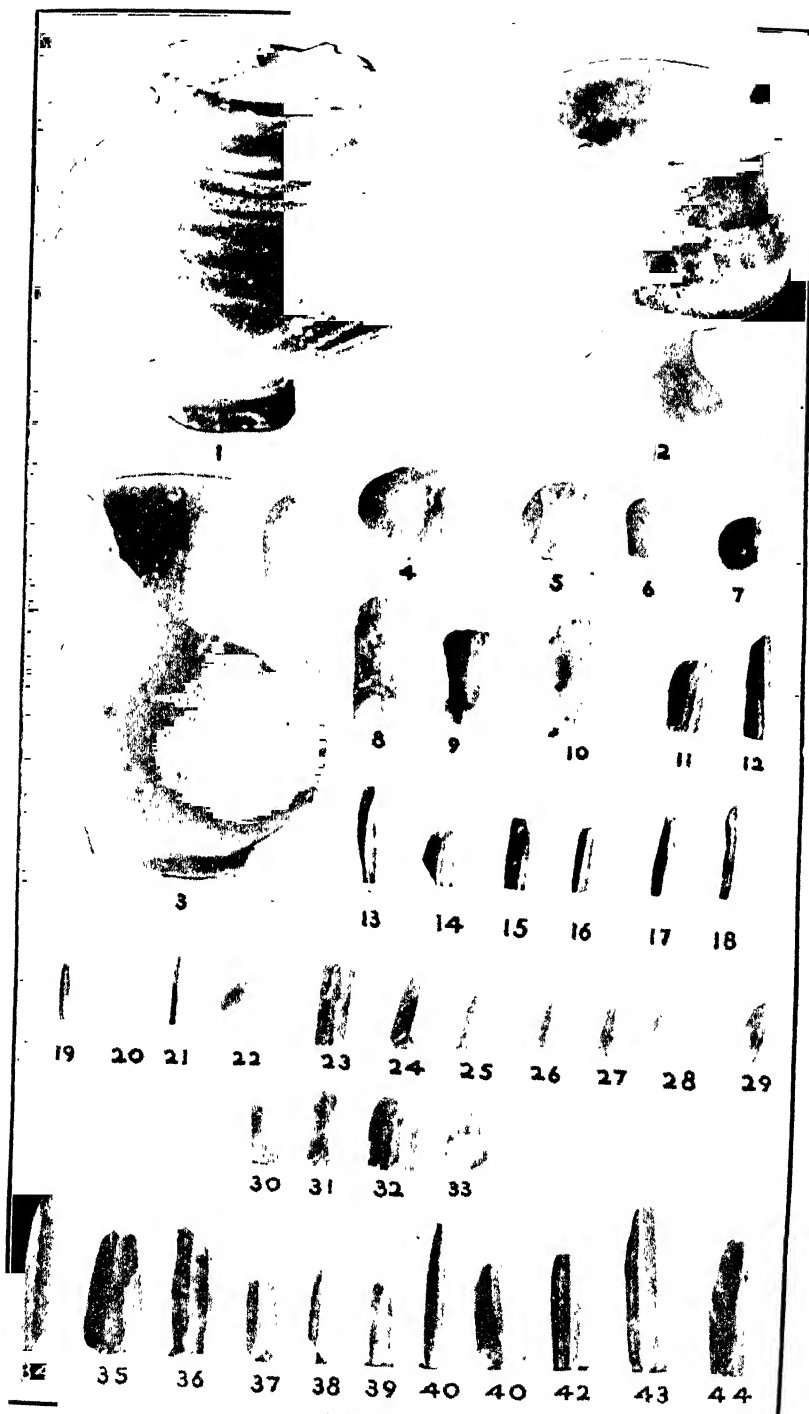


PLATE X



PLATE XI



PLATE XII



PLATE XIII



PLATE XIV

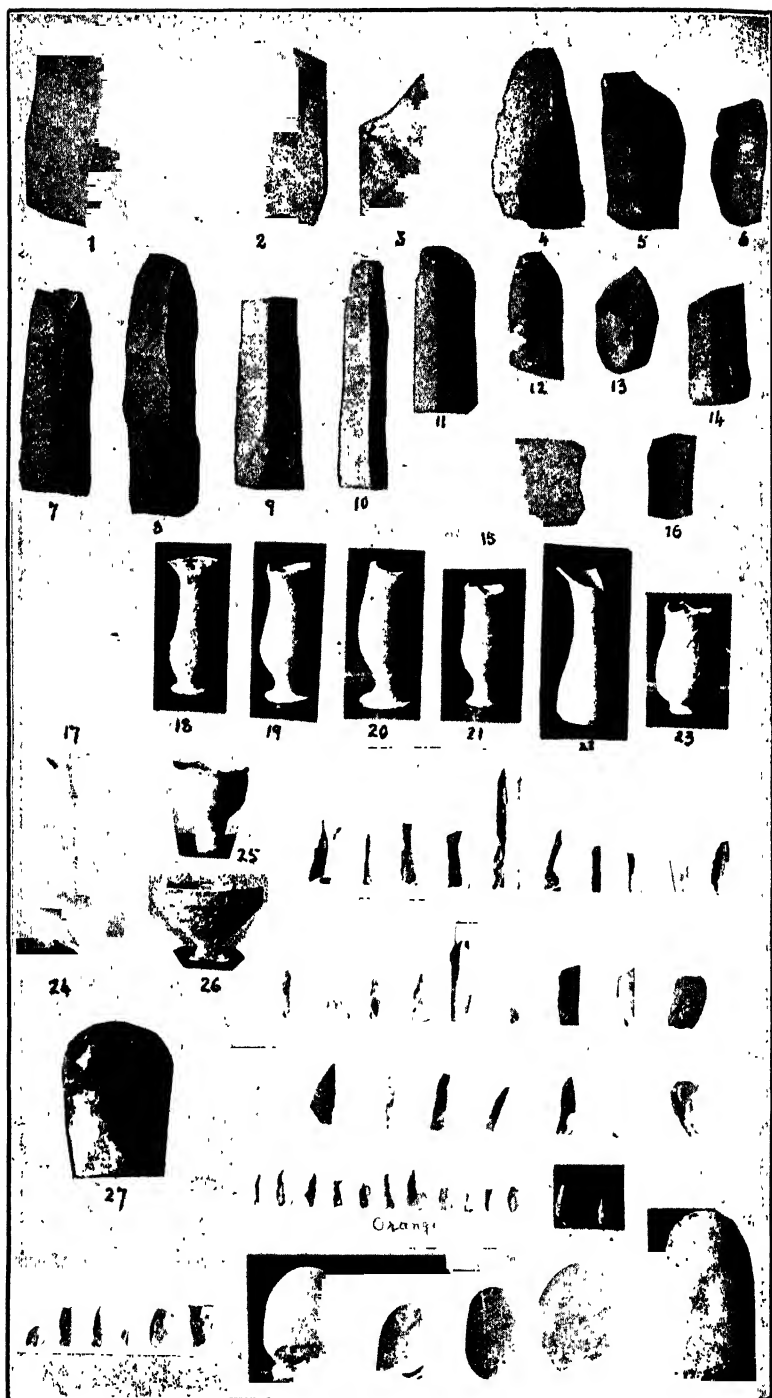


PLATE XV

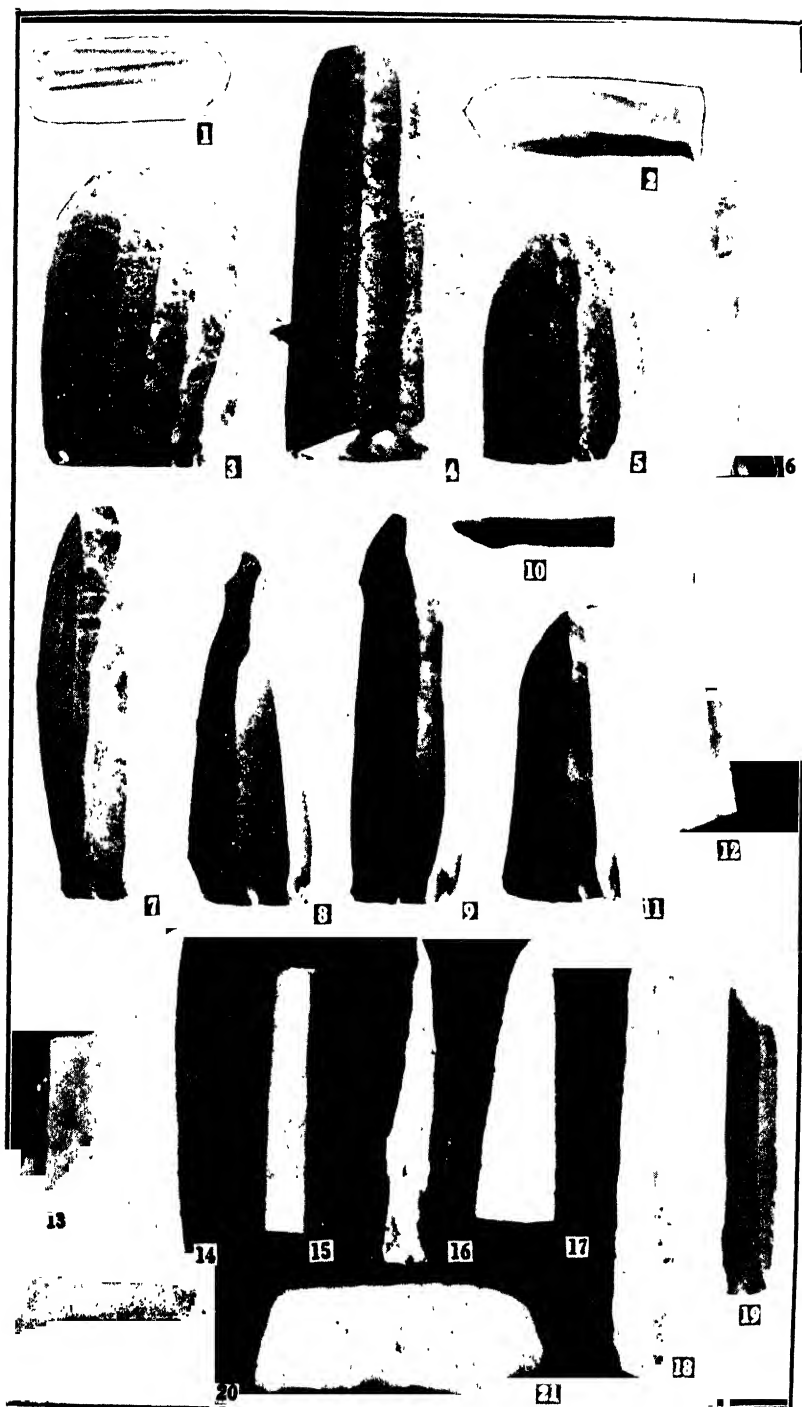


PLATE XVI

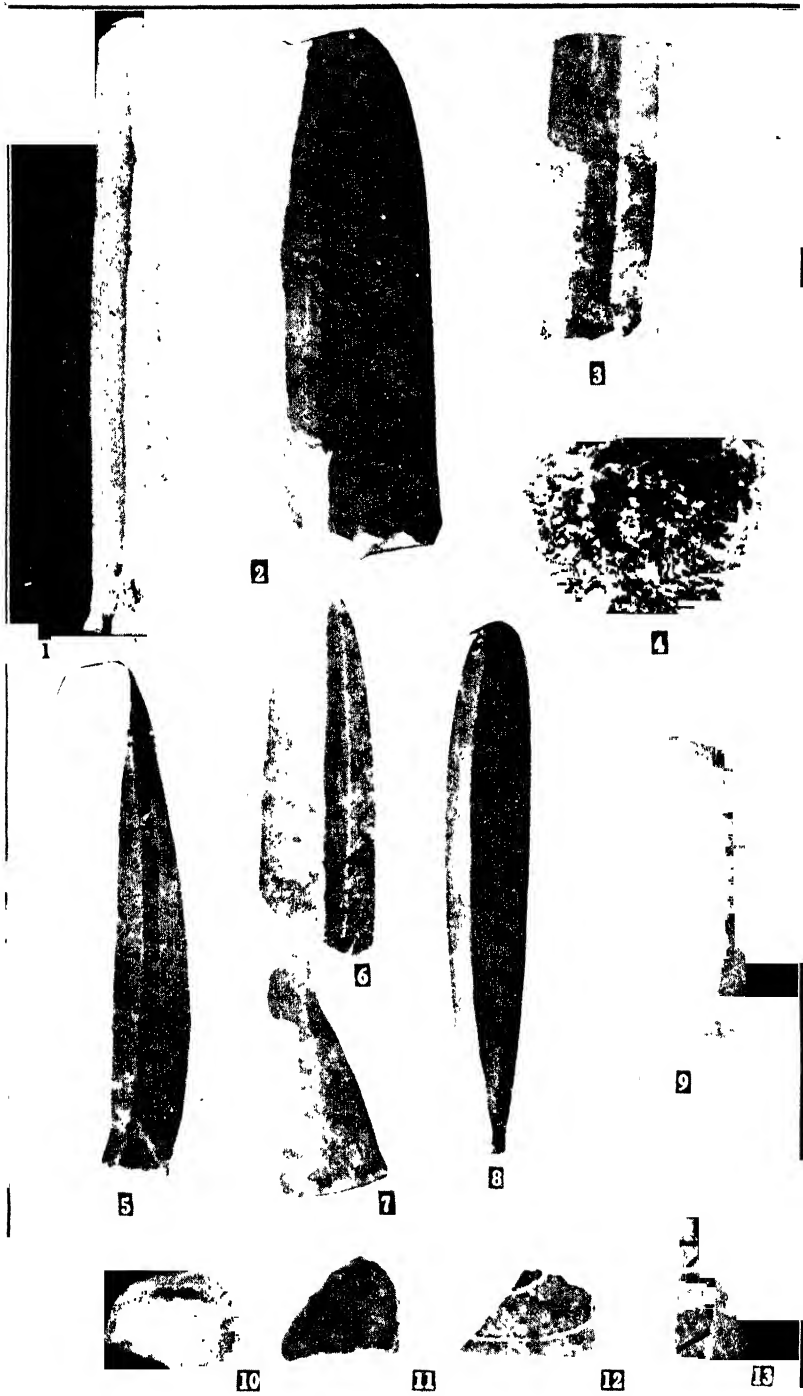


PLATE XVII

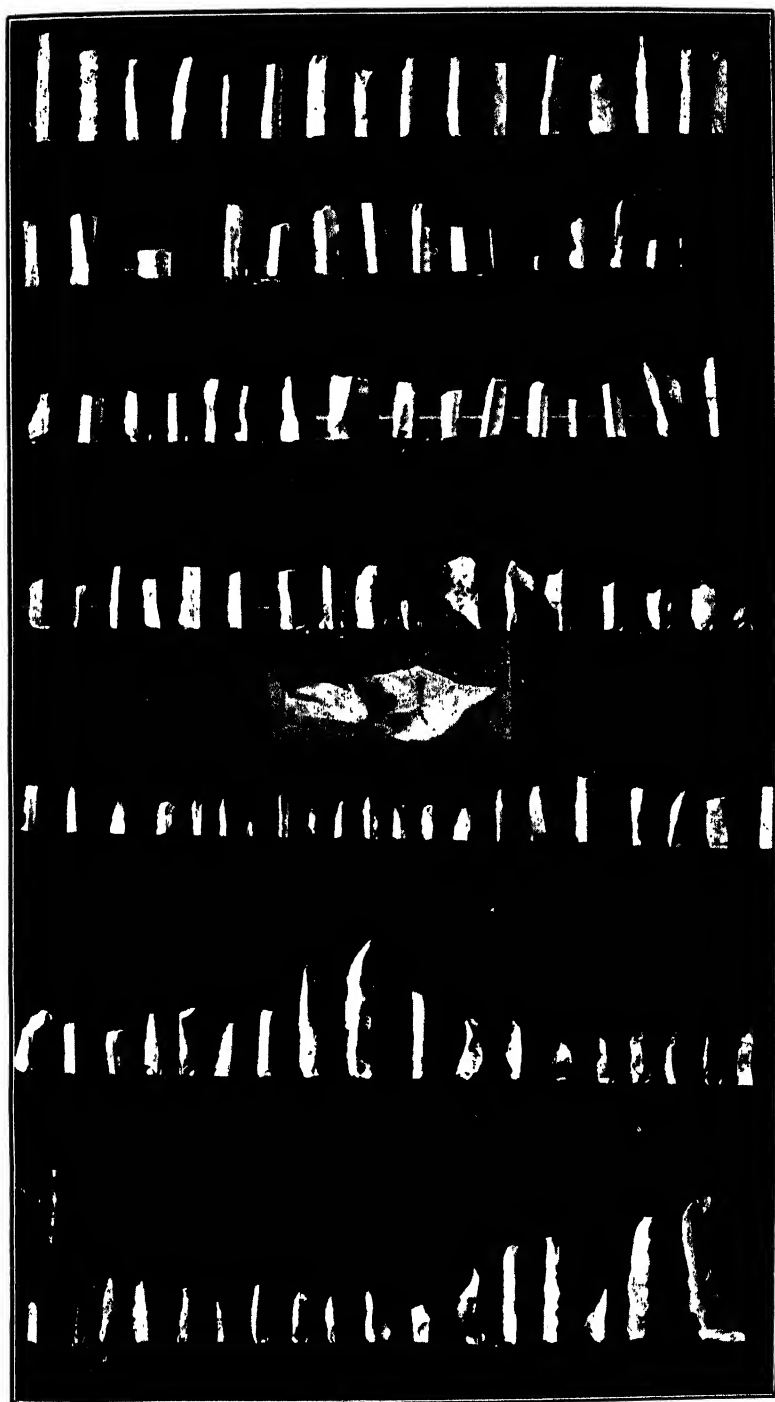
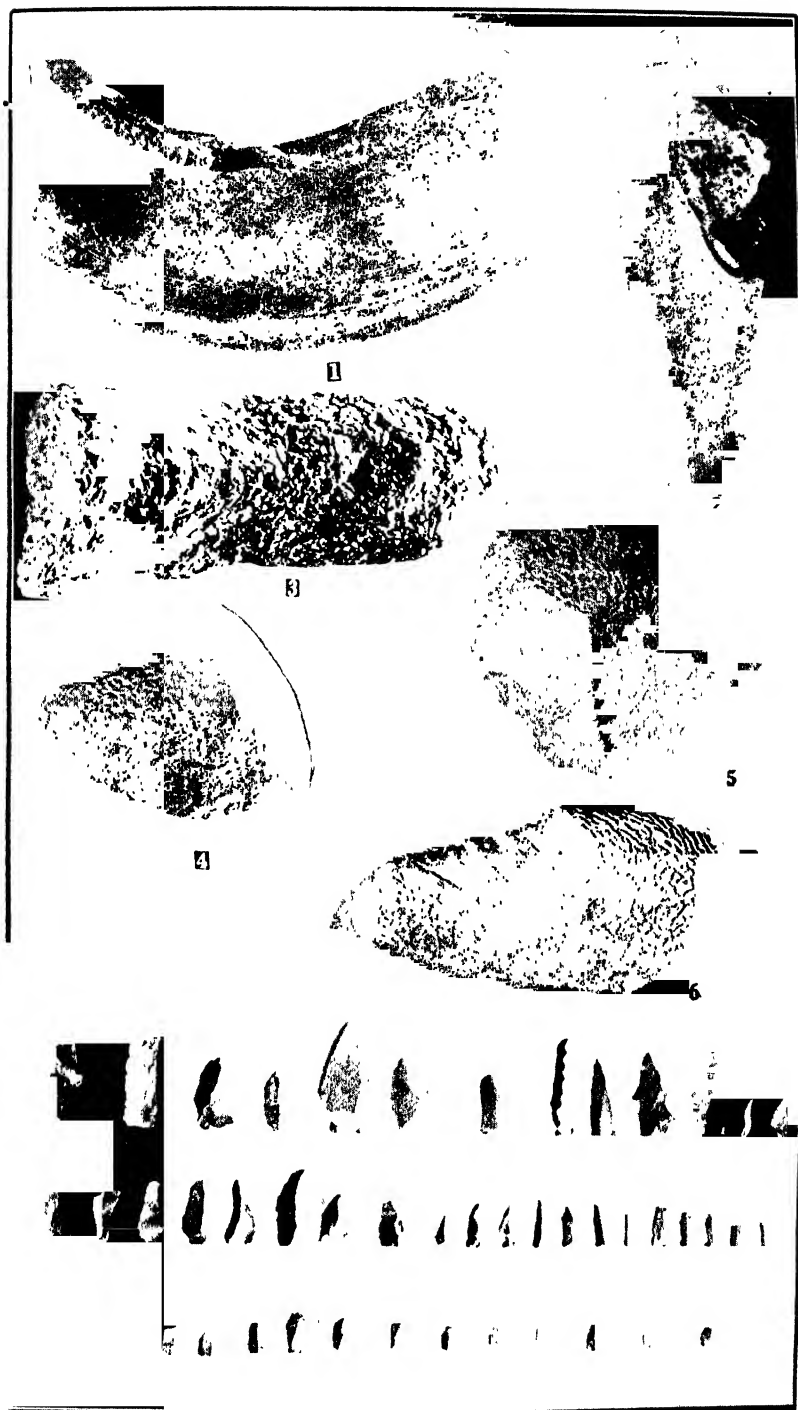


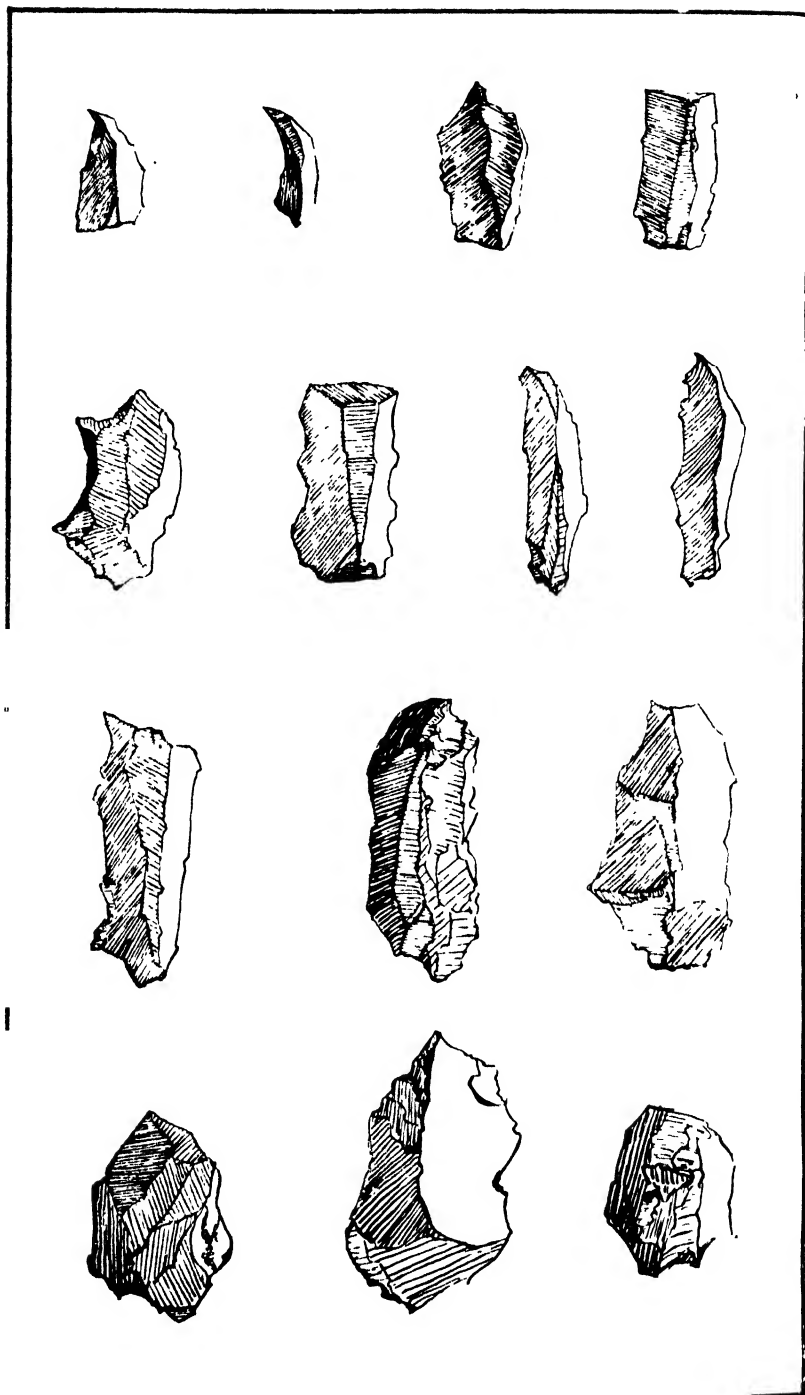
PLATE XVIII



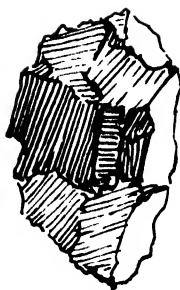
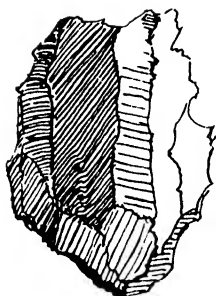
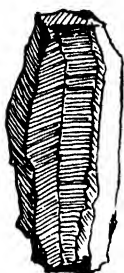
PLATE XIX



TEXT FIG. A



TEXT FIG. B



MĀHĀRĀṢṬRĪ LANGUAGE AND LITERATURE

THE MĀHĀRĀṢṬRĪ PRAKRIT

Māhārāṣṭrī is one of the important Prakrits receiving a full treatment at the hands of both the Prakrit grammarians¹ and Sanskrit rhetoricians. It is moreover the only language of the Dramatic group in which extensive literature is to be found. Daṇḍin², an author of the seventh century, says that Māhārāṣṭrī Prakrit is regarded as the language *par excellence* and *Setubandha* and other great works are written in that Prakrit. All the Prakrit grammarians from Vararuci onwards treat in their works Māhārāṣṭrī as the chief Prakrit language and in case of other Prakrits give rules about those features only in which they differ markedly from Māhārāṣṭrī. The value and importance attached to this Prakrit can be clearly seen from the fact that from comparatively early times the name Prakrit usually meant this language out of the whole group of Prakrits, an usage to which nearly all the writers subscribe.³ In the usual six-fold division⁴ of languages to be used in literature Prakrit occurs immediately after Sanskrit and stands there for Māhārāṣṭrī which is made evident by the specific mention of the names of other Prakrits that follow in the list. Both Vararuci and Hemacandra when they want to refer to Māhārāṣṭrī write *śeṣam māhārāṣṭrīvat*⁵ and *śeṣam prākṛtavat*⁶, expressions which mean that all other features which are not dealt with there are to be the same as those in Māhārāṣṭrī.

Reasons for this prominence are not far to seek. The grammarians of the Prakrit languages were in need of some system to be followed which would save them a good deal of their labour. They found in Māhārāṣṭrī the only language in which nearly all the forms were to be met with and thus afforded them a very convenient starting point for the study of the whole of the Prakrit group. It supplied a very good standard of comparison for other

1. Cp. Vararuci, *Prakṛta-Prakāśa* chapters 1-9; Hem. Prakrit Grammar VIII, 1-4, Sutra 259; Lakṣmidhara pp. 1-246; Mārkaṇḍeya 1-8.

2. *Kāvya-larṣa* 1, 37.

3. Besides Daṇḍin an explicit statement to this effect is given by Ratneśvara on *Sarasvatikaṇṭhābharaṇa* p. 227 "*dīvyā saṃskṛtā/prākṛtā māhārāṣṭrī* |.

4. Rudraṭa, *Kāvya-lāṅkāra*, 2, 12; Lakṣmidhara p. 1-2. p. 4, p. 26.

5. Var. 12, 32.

6. Hem. VIII, 4, 286. Lakṣm. pp. 252, 256.

languages. Hemacandra finds it convenient even in case of such a language as Ardha-Māgadhī which is, to all intents, quite different from Māhārāṣṭrī⁷. The Sanskrit rhetoricians, on the other hand, were in need of illustrations to their rules of poetics and found in this language an extensive literature to hand, both epic and lyrical in character which would serve their purpose of illustrating the minute rules of poetic composition to their satisfaction. The major portion of the examples in these works is taken over from the literature in this language which shows that it was rich enough to serve their purpose well. The existence of anthologies of stray verses which would require no context for their understanding also helped them in citing these verses, a fact of no small importance to them.

MĀHĀRĀṢṬRĪ AND ŚĀURASENĪ

This view of regarding Māhārāṣṭrī to be the normal Prakrit is recently challenged by Mr. Ghosh⁸ who has tried to prove that this supposition is based upon some kind of misconception. All along it was supposed by most of the scholars that the specific use of the word Prakrit as distinguished from its generic use to denote the whole group of the middle Indian languages, always meant Māhārāṣṭrī and was taken to be true on the authority of the grammarians like Vararuci and the statement of Daṇḍin in his *Kāvyaadarśa*.

Ghosh has put these facts to a searching criticism and has come to think that all the evidence on which this view is based proves to be unreliable and in fact is a mistake on the part of later writers, who failed to understand the stand-point of the earlier ones. He comes to the conclusion that Śauraseni was really the Prakrit *par excellence* and what is known as Māhārāṣṭrī is nothing but a later phase of it, developing under the influence of the Prakrit grammarians, if at all any reason is to be attributed for this change.

This view requires a careful consideration as it aims at the revaluation of the values of the various Prakrits and if true would lead us to a different solution of the whole of the Prakrit problem.

Mr. Ghosh relies upon a number of arguments to prove his position. Of them many may be admitted as facts proved, but it remains to be seen to what conclusion they should reasonably lead us. Hemacandra and many others do not mention the name Māhārāṣṭrī and we can also add Vararuci to them, for his 12th

7. A few remarks of Hem. make it clear that the basis of his Ārṣa is both Sanskrit and Māhārāṣṭrī. Cp. 2,146 ; 3,162 ;

8. Ghosh, Māhārāṣṭrī a later phase of Śauraseni, Journal of the department of Letters, University of Calcutta, Vol. XXIII, 1933.

chapter in which the word occurs only at the end, may be regarded as spurious and a later interpolation for which Mr. Ghosh has made out a strong case. Whether Vararuci wrote any 12th chapter which is lost and the deficiency was made up by some later writer producing the present inconsistency of arrangement or Vararuci could never have written any thing more than the first eleven chapters as he knew no Śauraseni other than what he treated in the first nine chapters as thought by Mr. Ghosh, remains doubtful. If accepted as true, Mr. Ghosh's position leads to the conclusion that the first nine chapters of Vararuci treat of Śauraseni. Now, many of the rules in them are taken over and worked out by Hemacandra⁹ and others to compose their Prakrit grammars and are made to serve the purpose of Māhārāṣṭri, a fact which cannot be explained unless one supposes that Hemacandra regarded the Prakrit of Vararuci's grammar to be Māhārāṣṭri. And this tradition can be pushed back to the times of Rudraṭa. Mr. Ghosh's argument that the Śauraseni rules are not adding anything new to the first nine chapters of Vararuci's grammar is also due to his neglecting many differences of a minute nature¹⁰. The difference admitted by Hemacandra is also small and mostly of a restrictive nature. In fact Vararuci has more rules and shows many more differences than given by Hemacandra. Vararuci says that in *vyākṛta* *t* becomes *ḍ* while Hemacandra includes this change in the features of Māhārāṣṭri¹¹. Vararuci notes that in words like *grāhṛa* *r* is changed to *i* which is put by Hemacandra in his treatment of Māhārāṣṭri¹². The Śauraseni peculiarity of the change of *jñ* to *ṇṇ* in *sarvajña* and *iṅgitajña* is a normal feature of Māhārāṣṭri according to Hemacandra¹³. The form *accharia* is also allowed in Māhārāṣṭri by him and he makes no provision for the peculiar verbal bases, *kar sumara*, *pekḥa* and *pulaa* in Śauraseni¹⁴. All this is sufficient to show that many of the peculiar forms of Śauraseni were included under Māhārāṣṭri by the time of Hemcandra. So one fails to see, if Hemacandra's rules are sufficient to make a difference between Māhārāṣṭri and Śauraseni how Vararuci's many more are insufficient to do the same. By a careful comparison of Vararuci's Śauraseni

9. Compare Var. 1, 2 ; Hem. 1, 44. Var. 1, 3 ; Hem. 1, 46. Var. 1, 4 ; Hem. 1, 66. Var. 1, 5 ; Hem. 1, 57. Var. 1, 10 ; Hem. 1, 67. Var. 1, 11 ; Hem. I, 72. Var. 1, 12 ; Hem. 1, 85 and so on.
10. Compare Var. 12, 13 ; Hem. 4, 260 ; Var. 12, 9 ; Hem. 4, 271 ; Var. 12, 19 ; Hem. 4, 272 ;
11. Cp. Var. 2, 8 ; 12, 4 ; Hem. 1, 206 ; 1, 207.
12. Var. 12, 6 ; Hem. 1, 128.
13. Var. 3, 5 ; 12, 6 ; Hem. 1, 56 ; 2, 83.
14. Var. 12, 30 ; 15. 17. 18. 8, 69. Hem. has no rules for Śau.

rules and their inclusion under Māhārāṣṭrī by Hemacandra it appears that the natural development in Prakrits appears to be a fusion of the dialectical differences due to their becoming more and more literary languages and not a greater differentiation to give rise to new languages as supposed by Mr. Ghosh.

Mr. Ghosh has pointed out that rule 2, 7 of Vararuci is a great obstacle in accepting his Śaurasenī as different from Māhārāṣṭrī. But as proved elsewhere this fact should lead us to suppose that the peculiar change of *t* to *d* is not a peculiarity of Śaurasenī, but it is not legitimate to conclude that there is no difference between these two languages on account of that single fact. The explicit statement of Daṇḍin cannot be explained away on any preconceived theory.

Mr. Ghosh has also tried to support his position from 'the theory of Prakrit' which he finds in the *Nāṭyaśāstra*¹⁵. He argues that the Prakrit that is scantily dealt with in that book can be no other than Śaurasenī, for all others named by Bharata can have no claims to the eminent position given to it there. Māhārāṣṭrī the only other Prakrit which can claim that position is not mentioned by Bharata in the list of his Bhāṣās and Vibhāṣās and was unknown to him. Śaurasenī is the only important Prakrit in the dramas and therefore Bharata must have dealt with Śaurasenī in his theory of Prakrit. This however remains at best doubtful and Bharata's treatment, coming as it does as a digression, gives us no clear hint that he is dealing with Śaurasenī. If Bharata names Śaurasenī and prescribes its use in the dramas to a considerable extent, one fails to see why he should give his treatment of Śaurasenī under the general name Prakrit, while it is equally probable that by Prakrit he means its generic connotation. This is made almost certain when we find him contrasting the Sanskrit and Prakrit Pāṭhya with which his treatment of Prakrit begins¹⁶.

That the word Prakrit denoted either the whole of the Prakrit group of languages or else in its specific sense, the Māhārāṣṭrī language can be proved from the consideration of a number of facts about its usage in Indian literature. Rudraṭa's enumeration of six languages in which Śaurasenī and Prakrit occur side by side leaves no doubt of their separate nature. His illustrations¹⁷ also show the same thing and it is certain that Rudraṭa clearly regarded them as distinct from each other and used Prakrit to mean Māhārāṣṭrī. The

15. Ghosh *The Date of Nāṭyaśāstra*. Jou. of the Dept. of Lett. 1935

16. *Nāṭyaśāstra* K. S. S. p. 214.

17. *Kāvyaalāṅkāra* 4 ; 11, 14, 17, 20.

evidence of *Daśarūpa*¹⁸ and *Kāvyaṃīmāṃsā* only shows that there the word Prakrit is used in its generic sense and that Māhārāṣṭrī played no important part in the dramas.

Rājaśekhara's views on Prakrits¹⁹ are of some interest and importance. Nowhere does he mention the languages like Māhārāṣṭrī, Śaurasenī and Māgadhī with their specific names. In his *Kāvyaṃīmāṃsā* we find many references to Prakrit languages but in all the places he appears to give a four-fold division of languages into Sanskrit, Prakrit, Paisāci and Apabhraṃśa. Thus, while describing the Kāvya-puruṣa²⁰ he says that his face is Sanskrit, his arms Prakrit, his hips are Apabhraṃśa and his feet are Paisāci. According to his conception of a Kāvīrāja²¹ he should be able to compose in all languages and for him there is no restriction of language, all being of equal value to him. He further notes that a particular language is favoured by the people of a particular country. The Gauḍas favour Sanskrit, the Lāṭas Prakrit, those living in Maru, Takka and Bhādāna Apabhraṃśa, the people of Āvanti, Pāriyātra and Daśapura favour Paisāci while the poet living in the Madhyadeśa favours all.²² He says that one should recite Sanskrit and Apabhraṃśa with grace and Prakrit and Bhūtabhāṣā with dignity. People living in countries like Magadha, east of Benares, speak Sanskrit well but are not able to recite Prakrit to prove which Rājaśekhara quotes a famous but ironical verse. The Lāṭas speak Prakrit charmingly but hate Sanskrit.²³ In the hall of the king Sanskrit poets should sit to the north, Prakrit poets to the east, Apabhraṃśa to the west and Paisāci to the south, a distribution based upon the places where these languages were current²⁴.

In his *Bālarūpāṇṇa*²⁵ Rājaśekhara calls himself well-versed in all the languages and points out that one and the same thought becomes different if written in Sanskrit, Prakrit, Apabhraṃśa and Bhūtabhāṣā or even by their combinations. He describes Sanskrit as beautiful to hear, Prakrit as elegant and possessing natural sweetness, Apabhraṃśa as very smooth and the Bhūtavacana as well-formed. In the *Karpūramañjarī*²⁶ he contrasts the tenderness of Prakrit with the harshness of Sanskrit.

18. *Daśarūpa* 2, 65.

19. *Kāvyaṃīmāṃsā* G. O. S. No. 1, Introduction p. xxv.

20. *Kāvyaṃīmāṃsā* p. 6.

21. *Ibid* p. 51.

22. *Ibid* p. 51.

23. *Ibid* p. 33.

24. *Ibid* p.p. 54-55.

25. 1, 10.

26. Act 1, 4.

From the information supplied by Rājaśekhara it is difficult to conclude that he knew of Prakrit to mean Śaurasenī only. He nowhere mentions Śaurasenī, nor Māgadhi nor Māhārāṣṭri and the natural conclusion appears to be that under the generic name Prakrit he includes all these three languages. His four-fold classification of the language is an extension of the one of Daṇḍin and Bhāmaha into the three-fold one with the addition of Paśāci, which by this time became independent of Prakrit, for what reasons it is difficult to say. That Paśāci was regarded as different from Prakrit and Apabhraṃśa is also known from the tradition of the four-fold division of Prakrits²⁷ as preserved by the eastern school of the Prakrit grammarians in later days. Daṇḍin knew of Paśāci and Māhārāṣṭri²⁸ and yet classified literature into Sanskrit, Prakrit and Apabhraṃśa²⁹. So also Rājaśekhara divided it into four and thus his use of Prakrit is not in a specific sense. His use of Śaurasenī in the drama, *Karpūramañjarī* proves that he knew of it and did not identify it with Prakrit. His one quotation from the *Gāthāsaptasatī*³⁰ also shows that he knew of Māhārāṣṭri and included it under the general term Prakrit.

Even though Hemacandra does not mention Māhārāṣṭri by name, that he makes a distinction between Prakrit and Śaurasenī follows from a number of considerations. His two Sūtras *śeṣaṇi prākṛtāvat*³¹ and *śeṣaṇi śaurasenīvat*³² make a difference between the two. His *Kūṃṛapālacarita* makes it still more evident, while his *Kāvyaṇuśāsana* makes a distinction between the two varieties of the Bhāṣāsleṣa Sanskrit-Prakrit and Sanskrit-Śauraseni³³. He further states that works like *Setubandha* are written in Prakrit and are divided into Aśvāsakas³⁴. That Hemacandra deals with Māhārāṣṭri in VIII, 1-3 and also regards that language to be the same as the one used in works like *Gāthāsaptasatī*, *Gauḍavadhā*, *Setubandha* and *Viśamabāṇatīlā* follows from his questions from these works³⁵.

27. It is into Bhāṣā, Vibhāṣā, Apabhraṃśa and Paśāci.

28. *Kāvyaḍaṛṣa* vv. 34, 38.

29. Ibid v. 32.

30. *Kāvyaṇuśāsana* p. 66.

31. Hem. 4, 286 ;

32. Hem. 4, 302.

33. *Kāvyaṇuśāsana* p. 228.

34. Ibid p. 337.

35. *Sattasatī* 1, 3 ; *Gauḍavaho* 188, 36, 319 ; *Setubandha* 1 ; 2, 12, 41 ; 2 ; 1, 24, 44 ; 3 ; 6, 7, 57, 4 ; 23 ; etc. *Viśamabāṇatīlā* ; *tīlā jānti*, on 3, 65.

Bhoja appears to draw for his remarks on Prakrit³⁶ both on Rudraṭa and Rājaśekhara which renders his own views obscure. He regards the verses in the dramas to be written in Śauraseni³⁷ and yet his remarks leave no doubt that he also regards Māhārāṣṭri and Śauraseni as distinct. With these facts before one it is evident that Dr. Chakravarti misses the real meaning of the word Prakrit when he calls the six-fold division of Rudraṭa to be logically defective.^{37a}

LINGUISTIC NATURE OF MĀHĀRĀṢṬRĪ

The nature of this Prakrit is fairly illustrative of nearly all the tendencies working in the whole of the Prakrit field. It is, as all others are, based upon the vocabulary of Sanskrit in the main and shows only a few words which cannot be traced to a Sanskrit origin for which reason they are designated as Deśi. The number of such words is however very small and it is also possible that many of them which are found in the usually accepted list of these words are nothing but obscure Sanskrit words or words used in a figurative sense³⁸ or lastly words greatly transformed so as to become different beyond ready recognition. Therefore except for a small number of these words the whole of the vocabulary of this Prakrit can be traced to a Sanskrit origin.

In the early works of this language the vocabulary is marked by the introduction of many Deśi words. In the *Sattasaī* we find them in abundance which is not the case with later works like *Setubandha* and *Gauḍavādha*. The cause for this difference appears to be that the former work is much more popular in character and is therefore found to preserve the language in a form nearer to the vernacular of the people than the language of the later works of the well known Sanskrit scholars. This change is further due to the growing influence of Sanskrit which was working over the Prakrit literature throughout its development, on account of its greater vogue. This fact invariably led the Prakrit writers to give preference to a Sanskrit vocabulary over genuine Prakrit one as being intelligible to a wider circle of readers and which they supposed would give their works a greater durability and which proved true to a considerable extent. Another characteristic of the vocabulary which is on increase in later-day works is the choice

36. *Sarasvatīkaṇṭhābharaṇa* KM. 94, pp. 140-149. vv. 13, 14, 16 are copied from Rājaśekhara.

37. Ibid p. 145.

37a. Linguistic Speculations of the Hindus.

38. Pischel Gra. Pra. Spra. Set. 9; Jacobi and Gune in their introductions to the editions of *Pañcīśattakāva*.

and favour shown to Sanskrit words which undergo no phonetic change or minimum change while coming over to the Prakrit language and which are technically called Tatsumas. This was again due to the desire of the writer to bring up his work as near Sanskrit as possible. On the whole this tendency of writing Prakrit in a purely Sanskritic manner must have been the chief cause of removing these popular languages far away from the spoken dialects of the people their original source and transforming them into literary languages.

The changes that have affected the Sanskrit vocabulary while coming over to this Prakrit are of some interest. There is, first of all changes in the genders³⁹ of words which differ in few cases between Sanskrit and Prakrit. Words like *śarad*, *prāvr̥ṣ*!, and *luraṇi* which are feminine in Sanskrit are regarded in Prakrit as masculine. Similarly words which end in *s* or *n* and which are neuter in Sanskrit usually become masculine in Prakrit. A few purely neuter words like *akṣi* and *vacana* now slowly take on the role of masculine words while a few originally masculine words like *gūṇa* become neuter. Words ending in *imā* and the word *añjali* now become feminine while *bāhu* when in the form of *bāhū* is regarded as feminine. If we look a little scrutinisingly at these changes we find that the rules which are operating here are the natural effects of the tendency of regarding the grammatical gender to be determined by the ending vowel of the word and not on the intrinsic nature of the object denoted by the word. Therefore if a word is found to end in *ā* or *ī* it is regarded as feminine in gender for the majority of words of these endings in Sanskrit are feminine. This is well exemplified by the case of *añjalī* and *bāhu* when it becomes *bāhū*, the first of them lengthens its ending vowel in Prakrit while the second now ends in *ā*. The three words *dāman*, *śiras* and *nabhas*, because they become *dāmaṇi*, *śiraṇi* and *naḥaṇi* in Prakrit remain neuter while others which become *jaśo tamo* regularly become masculine. There is further some confusion between masculine and neuter nouns which can ultimately be traced to the similarity of forms of these two classes. The evidence of Prakrit, it will be seen, is in full agreement with Brugmann's theory of the origin of the grammatical gender⁴⁰.

In the field of phonology of this Prakrit we find nearly all the laws of phonetic change working in more or less general manner. Changes in the quantity of vowels due to the loss or

39. Var. 4, 18-20; Hem. VIII, 1, 31-36; Laksm. 1, 1, 49-53.

40. Chakravarti; Linguistic Speculations of the Hindus p. 455.

shift of the accent are illustrated by the shortening of the vowels in words⁴¹ like *pāṇīya*, *alīka*, *karīṣa*, *śirīṣa* and lengthening in *prakāṣa*, *pravacana*, and others. These changes in the place of the accent itself are due to the fact that the accent is chiefly a stress accent in these languages while it was a musical one in the ancient Sanskrit. Syncope is found in words like *kumbhakāra*, *bhājana* and others where it is attributed to the influence of accent. It is possibly the reason why in a few words a consonant is doubled⁴² as in *tella*, *neḷḷa* etc. Māhārāṣṭrī is very rigorous in the application of rules of dropping the intervocalic consonants. Compared to other Prakrits it has a very airy appearance and affords greatest difficulties in identifying its words with their exact Sanskrit counterpart. A probable reason for this fact is suggested by its usage in songs and lyrics, a fact evinced by its exclusive use in verses in the dramas. As a result of this particular use the language lost all its consonantal structure and its hardness, leaving behind only a string of vowels and a few consonants to hold them together. It is however doubtful whether it is the result of this specific use of this Prakrit in the songs or that it was chosen for that purpose because of its loose and melodious character. Unless we get materials to determine the nature of this Prakrit before its introduction in the dramas we are not in a position to determine the question one way or the other. A more plausible explanation of this peculiarity is, however, to be found in the tendency of the grammarians to formulate general rules from scanty material. It was further accentuated by the close following of the rules by the later writers in Prakrit.

The distinctive features of this Prakrit are the wholesale dropping of the intervocalic stops⁴³, the reduction of all the aspirates to *h*⁴⁴, the change of *n* to *ṇ* at the beginning and middle of a word⁴⁵, where however the change at the beginning is against the testimony of the modern vernaculars, the use of single sibilant *s* and the changes of the unvoiced cerebral stops to voiced ones. Of the vowels, *r* is changed preferably to *a* wherein it agrees with Pali⁴⁶, *ai* and *au* to *ai* and *aii* while Hemacandra says⁴⁷ that *ai* and *au* are also allowed by some grammarians, a fact which may

41. Var. 1, 18 ; 1, 2 ; Hem. 1, 101 ; 1, 44.

42. Hem. 2, 98-99.

43. Var. 2, 2 ; Hem. I, 177.

44. Var. 2, 27 ; Hem. 1, 187.

45. Var. 2, 42 ; Hem. 1, 228-229.

46. Katre ; *Treatment of R̥ in Pali*. Annals BORI. XVI, pp. 200-201.

47. Hem. 1, 1.

be true in case of Māhārāṣṭrī, as it is found in its later stage of the formation of Marāṭhī. The conjunct *ry* becomes *jj* and *kṣ* changes more to *cch* than to *kkh* as in other Prakrits. *Jñ* and *ny* become *nn* and a few other tendencies which also appear in Marāṭhī.

Unlike other Prakrits Māhārāṣṭrī shows traces of phonetic changes which are otherwise regarded as the distinctive features of other languages like Śauraseni and Māgadhi, and these are found in a few words. Thus the Śauraseni peculiarity of softening⁴⁸ the hard consonants like *t* into *d*, *k* to *g*, and *th* to *dh* is found in words like *dā*, *dāva*, *gṇḍua*, *pidham*, or *pudham*, *savva* or *savvado*. Vararuci states that in words like *rtu* and others *t* is changed into *d*, *kirāta* becomes *cilādo*, the ablative singular terminations are *do* and *du* while it is also found in prepositions like *kado*, *jado*, *tado*. The Māgadhi change of *r* to *l* is met with in words like *caluqa*, *haliddā*, *jūhiṭṭhila* and *sukumāla*⁴⁹. But the most important instance of this tendency of mixing characters of other languages is the features of Apabhraṃśa that we meet with in Māhārāṣṭrī. There we have the change of *m* to *mv* or *vñ* in *ahiraṇṇu*, *ṇavai rovai*⁵⁰ and the opposite change of *v* to *m* as in *gamesai*, *kamandha*, *nīma* and *āmola*⁵¹. The existence of forms like *jūvū*, *sumiṇo*⁵² the presence of conjuncts with *r* in *vundru* and *bodraha*⁵³ and the change of *s* into *h* in *daha*, *coddaha*, *pāhūya*, *divaha*⁵⁴ and others all betray the Apabhraṃśa influence over this Prakrit⁵⁵.

Of these, the change of *t* to *d* is not a borrowing from the features of Śauraseni but a natural stage in the development of this language itself, mostly a survival of its traits in its early stage⁵⁶. The presence of other features it appears, is due to the extensive use of this language in nearly all the provinces outside its original home which in its turn appears to be the result of its being taken to be the only language suitable for writing literary works of some pretension. Naturally writers from outside its original country, while writing in it, introduced consciously or unconsciously forms from their own provincial dialects which were very familiar to them. Later on the grammarians, drawing their material from the

48. Hem. 1, 182 ; 1, 57 ; 1, 188 ; 1, 264 ; 2, 260 ; Var. 2, 7.

49. Hem. 1, 254 ; 1, 96.

50. Hem. 1, 243.

51. Hem. 1, 239 ; 1, 259 ; 1, 234 ; Var. 11, 16 ; 11, 19.

52. Hem. 1, 178 ; 1, 46.

53. Hem. 1, 53 ; for Vṛucaḷa Ap. He. 2, 80.

54. Hem. 1, 171 ; 1, 262 ; 1, 263 ; 1, 242.

55. Jacobi ; *Bhavisattakaha* p. 62 of the introduction.

56. Cp. *Śauraseni Prakrit* J. U. B. III, Part VI, pp. 47-52.

literary usage, appear to have included them in their treatment of this Prakrit as being sanctioned by good usage and so correct in it. In the present state of our information it is not possible to separate all such non-Māhārāṣṭrī element from its original features. It is equally possible to regard that this foreign element in this language is due to some kind of confusion on the part of the Prakrit grammarians and lack of finer distinctions between the different dialects which they never attempted. The Apabhraṃśa element, however, was introduced at a later stage and went on increasing as Apabhraṃśa spread widely.

The morphology of this language shows similar simplification and decay. There is no distinction to be observed between nouns ending in vowels and consonants. All words which originally ended in consonants are made vowel-ending either by dropping the final consonant or adding a vowel at the end, a tendency found in the classical Sanskrit itself. Further the whole of the declension was assimilated to the standard of the *a*-forms and words ending in other vowels also were given forms from the analogy of *a*-forms. Again no distinction was observed between long and short vowels which greatly simplified the intricacies of the Sanskrit scheme of declension. But along with this simplification there goes on the process of invention and a vast amount of new forms are due to the use of alternative bases for the declension of nouns and pronouns. Of the cases, the dative is lost and genitive takes its place. Here also, first the plural form was lost and the singular followed. The whole of the dual number was suppressed and its function was discharged by the plural, a natural course of development to be observed in many Indo-European languages⁵⁷. It was mainly due to the absence of any practical necessity of making a distinction between the things in pair which were usually denoted by the dual in Sanskrit and other ancient languages and things in group of more than two. Other forms of nouns show the effect of the working of the phonetic laws over the finished forms of the Sanskrit language while a few are to be explained by the mixture of the pronominal and nominal declensions and the effects of the law of analogy.

Hemacandra's treatment of the pronominal forms⁵⁸ leaves no doubt that this vast array of forms must have been the result of some confusion of dialectical differences which are neglected by the grammarian and the indiscriminate use of different bases due to a optional working of a phonetic law or even some scribal error.

57. Brugmann, *Vergleichende Grammatik* pp. 413-417.

58. Hem. 3, 90-117.

The ablative appears to be particularly rich both in case of nouns and pronouns. The most distinctive features of Māharāṣṭri in declension are the locative singular in *māi*, ablative in *ā* and nominative in *o*.

The conjugation of the verbs also has a similar line of development. The ten tenses and moods of the classical Sanskrit and the Vedic dialect are reduced to two tenses and two moods. The present and future are retained and the imperative and the potential moods preserved their full conjugations. The past tense was represented by one form derived from the aorist and served the purpose of all the persons and numbers. But the function of the past tense was taken over by the past passive participle which was regularly corrupted from the Sanskrit forms. In Sanskrit itself this method of using nominal forms for the finite verbs was on increase and gave rise to what is called the nominal style of writing⁵⁹. The distinction between the two Padas which was loosened in the Epic Sanskrit now completely vanished and terminations of both were indiscriminately used to form forms. The Parasmaipada was favoured and soon drove the other out of the field.

In the formation of the verbal derivatives this Prakrit, like many others, appears to draw more on the Vedic language than the Classical Sanskrit. This forms one of the links which connect the Prakrit language with the Vedic dialect without the intervention of the Classical Sanskrit⁶⁰. The richness of the forms of the gerund betrays their dialectical origins. The peculiar features of Māharāṣṭri appear to be the passive formed by the addition of *ijja*, future with the help of *hā* and *hī*, the gerund in *āṇa* and a few verbal substitutes which also find their way in the modern vernacular, Marāṭhi.

THE HOME OF MĀHĀRĀṢṬRĪ

The name of this Prakrit would indicate that the home of this language was the country of Māharāṣṭra at least at the time of getting that nomenclature, in its early stage. It is often contended that various Prakrits that are preserved to us in literature are not the real vernaculars of the people of various localities but are to be considered as literary languages and therefore have no local basis to be called their home. Such a view is based, however, on the mistaken belief about the nature of these Prakrits and the nature of a spoken language. The Prakrits are no doubt literary

59. Bhandarkar ; *Wilson Philological Lecturers*.

60. Piechel ; *Gra. Pra. Spr. Set. 6*.

languages and are essentially known to us in a form preserved by scholars in their literary productions of more or less scholarly nature. In this sense they are emphatically literary languages. But it is equally true that they are in no way to be regarded as artificial languages created by some particular social group without any spoken language at their basis. Originally Prakrits were the spoken languages of the people and their true vernaculars. In course of time they were refined and polished greatly with the help of the grammarians and were made suitable for literary expressions. Such a process naturally involved the removal of irregularities, the use of a few favoured forms and a more strict and accurate use of words and forms which come up to the standard of the grammarians. It is true that in this process of refinement and elevation some rules were carried to a greater extent outside their proper sphere than was warranted by the facts of the case, in the zeal to form comprehensive rules of grammar. All the same, these Prakrits are based on definite dialects which were the means of communication of the masses and so their vernaculars. The home of a Prakrit naturally means the locality where the dialect at its basis was current and spoken by the people.

In determining the home of Māhārāṣṭrī it is but natural that the country of Māhārāṣṭra should be regarded as the place where this language arose. But such a suggestion is often repudiated and even attempted to be disproved. It is pointed out⁶¹ that Māhārāṣṭrī was used throughout India and as the language of the Prakrit epic and lyric was current all over the country. As early as the sixth century A.D. the *Setubandha* was written in that language in Kaśmīr at the other end of the country. Others try to prove that Māhārāṣṭrī has nothing to do with this country as its present vernacular Marāṭhī is not closely related to this Prakrit. But viewed impartially one has to admit that the real home of this Prakrit is no other than the country of Māhārāṣṭra. Besides the name which itself is an indication of this fact, we have clear traces of the Māhārāṣṭrī language to be met with in Marāṭhī⁶², which shows in many ways a further development of this Prakrit. This is shown by the vast amount of Prakrit words which are peculiar to Māhārāṣṭrī and to be found in Marāṭhī, while other Prakrits differ from both of them. A comparison of words like *mahārāṣṭra*, *marahaṭṭa*, *marhāṭhā*; *sadyā*, *sarisa*, *sārakhā*; *pakva*, *pikka*, *pikane*; *aṅgāra*, *iṅgāla*, *iṅgaḷa*; *lalāṭa*, *nidāla*, *nidhaḷa*; *khudā*, *khudane*; *śayyā*, *sejā*, *seja*; *vallī*, *vellī*, *velī*; *ūrdra*, *olla*, *ole*;

61. Hornle; Introduction to Caṇḍa's *Prākṛta Lakṣaṇa* B. I.

62. Grierson; Linguistic Survey Vol. VII, pp. 5-7.

nirjhara, *ojjhara*, *ojharane* ; and a host of others would convince us about the close connection between these two languages⁶³. Add to this, the formation of the gerund in *ūṇa* and a few verbal bases and the Deśi words common to both and we have to admit that they are the languages related as mother and daughter towards each other. As regards its use throughout India it is found only when the language had attained prominence. But even then we have evidence to think that in its early stage it was used in the country of Māhārāṣṭra and later spread all over India for the writing of Prakrit epics on account of its great popularity. This is sufficiently proved by the fact that the oldest work in this language the *Sattasaī* of Hāla is a purely Māhārāṣṭrian production which appears from its constant references to mount Sahya and the river Godāvarī.

THE NAMES OF THE COUNTRY AND THE LANGUAGE

To understand the origin and development of this Prakrit we must briefly review the early history of this country to see the conditions in which this language must have originated and developed. It is not possible to determine with precision the date of the colonisation of the Deccan by the Aryans of the North and particularly the aryanisation of Māhārāṣṭra. There is no mention of the country south of Vindhya in the early Vedic literature⁶⁴. Pāṇini refers to Kaccha⁶⁵, Āvanti⁶⁶, Kośala⁶⁷, Kaliṅga⁶⁸ all of which lie to the north of the river Narmadā. Only Āśmaka⁶⁹ that is mentioned by him, lies to the south of that river. So he appears to be ignorant of the major portion of the South India. The *Aitareya Brāhmaṇa*⁷⁰ calls Bhīma a prince of Vidarbha and the story of Śunaśśepa⁷¹ mentions by name such tribes as Āndhras, Puṇḍras and Mūtilas which are probably South Indian tribes. Therefore most of the scholars agree in regarding that the colonisation of South India must be dated later than the time of the great grammarian Pāṇini who is variously assigned from 800-400 B. C. In later literature we find clearer traces of the knowledge of this country as in the

63. The big list given by Hem. of the Dhātvaśeṣas in his 4th chapter reveals many Marāṭhi words. Dr. Vaidya has collected them in one of his articles.

64. Bhandarkar ; Early History of Deccan.

65. Pāṇini 4-2-133.

66. Pāṇi. 4-1-176.

67. Pāṇi. 4-1-171.

68. Pāṇi. 4-1-170.

69. Pāṇi. 4-1-173.

70. VII, 34, 9.

71. *Āit. Brah.* VII, 17, 19.

*Suttanipāṭa*⁷² one of the ancient works of the Pāli canon which gives us the story of Bāvari who leaves off the country of Kośala and comes to Aśnaka in South India. Kātyāyana⁷³ refers to Pāṇḍya and Coḷa two famous countries in the extreme south. There is a reference to Tāmbraparaṇi in the inscription of king Aśoka⁷⁴ while Kauṭilya refers to a king Bhoja Dāṇḍakya who lived long before him.

According to a tradition preserved in the *Rāmāyaṇa* we find that there were two different settlements in South India of the colonising Aryans. The first of them was led by Bhṛgu and his descendants who entered that part of Kōṅkaṇa on the shore of the western ocean and which was known by its other name Aparānta. The eastern part of the country called Vidarbha was early colonised by the sage Agastya and his followers who later on occupied the middle country called the Daṇḍakāraṇya a name explained by the tradition with the story of a king Daṇḍaka who insulted the sage Cyavana and was cursed by him. Even though the traditional names are susceptible to objections this appears to be the only way of overcoming the natural obstacle of the mountain Vindhya and must have been the most easy route for the incoming Aryans. Dr. Bhandarkar⁷⁵ has suggested the precise route to be from Māhiṣmatī through Vidarbha to Pratiṣṭhāna mostly relying on the correctness of the account of the route of the pupils of Bāvari as given in the *Suttanipāṭa*. From the name Pāṇḍya and the name of the southern town Madurā he comes to the conclusion that the people who colonised this part of the country came from Mathurā and belonged to the tribes to which the Pāṇḍavas belonged. S. K. Ayangar⁷⁶ puts the date of this southern migration on either side of 750 B. C.

From the nature of the Prakrit it appears probable that immediately after the Aryan migration in the country this Prakrit language was formed as a result of the intermixture of the Aryans and the original inhabitants of the country. It is however impossible to decide whether this Prakrit was a result of the change that affected the ethnological structure of the incoming Aryans or due to the transference of the language from the Aryan population to the aboriginal people who distorted it and turned it into the present Prakrit form.

72. *Suttanipāṭa* V.

73. On Pāṇini 4-1-108, 175.

74. Rock Inscription No. 2.

75. Carmichael Lectures 1918 pp. 1-41.

76. Ancient India p. 5.

The explanation of the name of this language offers unusual difficulties. If we are to follow the analogy of the names of other Prakrits we will have to say that like Śaurasenī and Māgadhi, Mahārāṣṭrī also derives its name from the country from which it took its origin. But there are some difficulties in accepting this natural explanation which cannot be ignored. Unlike the other two names of Magadha and Śurasena, Mahārāṣṭra is not the oldest name of the country and is said to be very late in its origin, according to the majority of scholars. It is sufficiently proved that the original name of this part of the country was Dakṣiṇāpatha or Mahākāntāra or even Mahāṭavi. Vidarbha alone is known from very early times. The country got the specific name Mahārāṣṭra very late. Aśoka's inscriptions refer to Rāṣṭrikas which must be located in South India and the inscription of Samudragupta mentions one Devarāṣṭra which is usually taken to be identical with the present Mahārāṣṭra but which Allan⁷⁷ tries to identify with the Vizagapattam district of the Madras province. The oldest reference to this country is to be found in the *Bṛhatsaṃhitā*⁷⁸ of Varāhamihira who flourished about the fifth century A.D. In A.D. 611, it is mentioned in the inscription of Satyaśraya Pulakeśin. In his *Kūmasūtra*⁷⁹ Vāstāyana mentions both the name of the country and its inhabitants Mahārāṣṭrikas and his work is approximately dated 400 A. D.

This late origin of the name has led scholars to speculate about its probable significance. The most complicated and unsound theory put forth is that of Rajawade⁸⁰ who says that the Mahārāṣṭrikas were the followers of the king of Magadha and because of the spread of the Buddhist religion in that country, they migrated to the south and in course of time absorbed the earlier tribes of Rāṣṭrikas and Vairāṣṭrikas which gave rise to the Trimahārāṣṭrikas which is found mentioned in some inscriptions. They further mixed themselves with the Nāga people about 400 A.D. Vaidya has suggested that the name Mahārāṣṭra is due to the mixing up of a number of small kingdoms like Vidarbha, Aśmaka, Pāṇḍurāṣṭra, Goparāṣṭra and others which took place about the beginning of the Christian era. Kane⁸¹ also agrees in taking the word to mean the great kingdom. Dr. Ketkar⁸² however insists in taking the word

77. Shorter Cambridge History of India p. 90.

78. Ed. by Kern 10, 8.

79. Ed. by Durgāprasād p. 131, 154.

80. Itihāsa āṇi Aitiḥāsika lekha p. 290 foll. Introduction to the *Rādhāmādhāvavilāsacampū* set. 84 foll.

81. Ancient Geography and Civilisation of Mahārāṣṭra JBBRAS. Vol. XXI.

82. Prācīna Mahārāṣṭra, Śātavāhanaparva, Summary pp. 12-16.

to mean a country inhabited by the tribes of Mahārs and Rāṣṭrikas and thinks that the country got the name at about the seventh century A.D.⁸³.

We have, however, ample evidence to show that this Prakrit was called Māhārāṣṭrī at a time much earlier than the date to which the name of the country is assigned at the earliest. Vararuci mentions it and deals with it at great length and his date is fairly early. The *Sattasaī* can be reasonably assigned to the beginning of the Christian era and what is still important is that it presupposes a vast literature earlier to it. It is equally improbable to suggest that the country got its name from the language. The grammatical form goes against it. The only alternative left open is to regard that both the country and the language got their names from the name of the tribe or group of tribes who occupied this tract from early times and who were known by the name Rāṣṭrikas to people outside. From the fact that Bharata does not mention this Prakrit by name and that his text shows Prakrit verses which are not in Māhārāṣṭrī it is often argued that the language was not known to him. But it is more reasonable to suppose that at the time when he wrote the language was known by its earlier name Dākṣiṇāṭyā. It is not a mere dialect of Māhārāṣṭrī as the later grammarians supposed but the original language on which the literary language was based and was named Māhārāṣṭrī at a later stage. Ghosh simply sets aside this consideration without sufficient reasons.

THE ORIGIN AND DEVELOPMENT

This language slowly forming itself in the few centuries about the Christian era must have got a strong impetus to development in the prosperous reign of the Āndhrabhr̥tya kings which attained its pinnacle of glory in the reign of Gotamiputra Śātakarṇi. Hāla, the compiler of the famous *Sattasaī* is traditionally supposed to be the seventeenth king of this dynasty and there are many old traditions which fully evince the inclination of these kings towards Prakrit⁸⁴. So it is more than probable that just in the reign of these kings Māhārāṣṭrī Prakrit attained a very high degree of eminence to which end the territorial patriotism of these kings must have contributed not a little.

The wide diffusion and the rapid growth of this Prakrit can be well explained by the political changes that were going on in the

83. For the whole problem cp. Grierson, Ling. Sur. Vol. VII, p. 15; D. R. Bhandarkar, Carmichael Lecturers 1918 Lect. 1, pp. 1-41; Pendshe, *Mahārāṣṭrācā sānskr̥tika itihāsa*; Chap. I.

84. *Kāvyaamṛtsā* p. 50, *Sarasvatīkaṇṭhābharaṇa* p. 143, and the introductory of the *Bṛhatkathā*.

country of its origin. Along with the growing power of the Āndhrabhṛtya kings and the spread of their empire even in the northern countries because of their conquest of Ujjayini this language must have also acquired a prestige which must have helped in its spread. If we accept the place of *Setubandha* to be Kaśmīr we can see that the language spread early to the other end of India. At the time of Kālidāsa it found its way in the dramas and slowly superseded other dialects in lyrics and songs. In the *Mṛcchakaṭikā* there are only a few verses in Māhārāṣṭrī while the majority of them are found in Śauraseni or Māgadhī according to the language of the speaker. The authenticity of the few Māhārāṣṭrī verses is also doubted by some⁸⁵ who would prefer to read all of them in Śauraseni or Māgadhī. The date of this drama is not finally settled but in all probability it is earlier than Kālidāsa. It is however to be noted that the date of the introduction of this Prakrit in the dramas does not mean it to be the date of its origin. On the contrary it suggests that it existed long before it and was taken over in the dramas because of its popularity in literature.

It is not easy to determine the date of the beginning of this language. Jacobi has suggested that the third century is the probable time for the beginning of its use in writing lyrics and songs and it was later adopted in the dramas at the time of Kālidāsa. He points out that Bharata nowhere mentions it in his *Nāṭyaśāstra* and the dramas of Aśvaghoṣa and Bhāsa show no trace of this language. This evidence would lead us to date this language after the third century when Bhāsa and Bharata flourished. This position is further strengthened by his theory that even in case of epics and stray verses Māhārāṣṭrī was not used at the time of *Nāṭyaśāstra* but its place was taken by some other Prakrit dialect. Keith⁸⁶ also emphasises the same facts and puts the language after the fourth century adding that the dropping of the intervocalic consonants was a very late tendency and is absent in ancient Prakrits.

The evidence adduced above leads to no definite conclusion. The fact that the older dramatists have no verses in Māhārāṣṭrī and that Bharata does not mention it is no doubt to be explained on the supposition that from early times this language played no important part in the Sanskrit dramas. Therefore neither the dramatists nor the theorist found it necessary to use or mention it in their works. But its use in other literary fields should not on that account be dated so late. The Pre-classical Prakrit or the older Śauraseni

85. Hillebrandt and others.

86. History of Sanskrit Literature. Part I, Classical Sanskrit Literature pp. 20-21.

had a restricted use for the Dhruvās in the dramas. But for the writing of the epics and lyrics there is no evidence to show that it was used instead of Māhārāṣṭrī and the later usage makes it extremely probable that from the very beginning Māhārāṣṭrī was used in them. The oldest work, the *Sattasaī* confirms the same and when we find that it presupposes a vast earlier literature from which it was selected, it is but natural to date the origin of this language a few centuries earlier than the date assigned to it by Jacobi and Keith.

DIALECTS AND USE IN LITERATURE

Prakrit grammarians do not give sub-dialects of this language. There are many dialects found in case of other Prakrits like Śauraseni and Māgadhī and it appears strange that Māhārāṣṭrī should have no dialects particularly when it extended over a very wide area, a fact which should contribute to the emergence of many dialects. This fact may be due to its early standardisation and the activity of the grammarians must have been wide and valued enough to fix its form early. This left no scope for later writers to deviate from the norm laid down by the grammarians and must have been the chief agency to make the language uniform. But there are traces of the existence of some dialects in the present language itself like the use of so many forms for a particular formation of grammar. It is best explained by supposing that the grammarians overlooked the minute and fine distinctions of dialects and put all the forms together in writing their grammars. The presence of a few phonetic tendencies which are really foreign to the spirit of this language goes a long way to prove that it had formerly dialects which were soon forgotten and their peculiarities incorporated in the standard language. Its wide use in writing the epics and its early stereotyping in the form of a literary language are responsible for this to a certain extent.

The practice of the dramatists also gives us no additional information about the dialects of this Prakrit. Pṛthivīdhara⁸⁷ says that both the characters Candanaka and Viraka in *Mṛcchakaṭikā* speak a dialect called Āvantikā and gives its peculiarity to be the presence of the sibilant *s* and richness in proverbial sayings. According to Mārkaṇḍeya this language is a mixture of both Māhārāṣṭrī and Śauraseni which agrees with the few passages found in the drama. From these facts it is difficult to classify this dialect as either that of Māhārāṣṭrī or Śauraseni. From a

remark of Candanakā that the southerners speak indistinctly Pischel suggests that Candanaka is not speaking Āvantikā but another dialect called Dākṣiṇātyā which is mentioned by Bharata and the *Sāhityadarpaṇa*. If this is true it differs very little from Māhārāṣṭrī or even Āvantikā. Woolner would take both these dialects as nearly related to Śaurasenī because the passages in the Mss. show many Śaurasenī features⁸⁸.

Both Mārkaṇḍeya and Rāma Tarkavāgīśa mention the dialect Dākṣiṇātyā and Viśvanātha⁸⁹ tries to make it identical with the dialect Vaidarbhiḥ. Lassen long ago classified it along with Māgadhī and Ardha-Māgadhī because he found them mentioned together but for no other logical reason. The names of both the dialects would suggest that they are the dialects of Māhārāṣṭrī Prakrit and current in South India and the country to the north of it. Grierson⁹⁰ has further suggested that these late references to the dialects may be to the dialects of the present day Marāṭhī which is certainly old enough to receive mention from these writers.

All the writers on poetics are unanimous about the role this Prakrit plays in the Sanskrit drama. The song of the ladies who usually speak Śaurasenī are to be written in Māhārāṣṭrī. But Bhoja alone calls a song from the *Śakuntalā* to be written in Śaurasenī. His readings also preserve the change of *t* into *d* in that gāthā. But it is difficult to believe in the statement of Bhoja in this respect. The softening of *t* is not foreign to Māhārāṣṭrī and this must have misled him to call the verse to be written in Śaurasenī as he came at a time when this change was taken to be the distinctive feature of the Śaurasenī Prakrit.

The epics were no doubt written in this Prakrit alone. As remarked by Daṇḍin⁹¹ Kathās were also composed in it but we are not sure whether they were in prose or verse. Taking into consideration the fact that there is no prose in existence in Māhārāṣṭrī it appears more probable to regard them as written in verse. This is confirmed by Namisādhu⁹² who says that they are to be written in other Prakrits but not in prose. Bhoja⁹³ says that it is used by characters of middle status.

88. Introduction to Prakrit p. 189.

89. *Sāhityadarpaṇa* p. 173.

90. Ling. Surv. Vol. VII, p. 15.

91. *Kāvyaadarśa* 1, 38.

92. *Kāvyaalankāra* p. 171.

93. *Sarasvatī*, p. 144.

MĀHĀRĀṢṬRĪ AND MARĀṬHĪ

Another complicated problem about this Prakrit is to trace its legal descendant among the modern vernaculars of India. It is no doubt Marāṭhī which can lay best claims for it and it is the present day vernacular of the country of Māhārāṣṭra where Māhārāṣṭrī also took its rise. The older view that Marāṭhī is to be derived from Pāli is clearly wrong. Garenz⁹⁴ first tried to prove the close relation between Māhārāṣṭrī and Marāṭhī. He pointed out that the Marāṭhī gerund in *ūnu* is from the Māhārāṣṭrī one in *ūnu*, both have a feminine form of the demonstrative and relative pronouns, the emphatic particle *eṭa* in Māhārāṣṭrī is found in Marāṭhī in the form of *eca* and lastly both have a good many peculiar words. Pischel has accepted this view, which was first called in question by Grierson⁹⁵. Later on Grierson also admitted it as true and adduces a few more points of similarity. Marāṭhī shows its near relation to Māhārāṣṭrī in features like the formation of the gerund, the change of *ai* and *au* into *ai* and *ai* which later revert to their original forms, the favour shown to the rule of simplifying the conjunct by lengthening the preceding vowel, the change of *ks* to *cch*, the peculiar basis of the personal pronouns of the first and the second persons, and a host of words showing abnormal changes common to both of them. Many Deśī words in Māhārāṣṭrī are found in Marāṭhī and similar is the case with the Dhātvaḍeśas.

Even when we accept that Marāṭhī is a descendent of Māhārāṣṭrī it remains yet to trace the exact line of development by which it originated. Grierson following his general scheme of the development of all the modern vernaculars postulates the existence of an intermediate stage between the two languages which he prefers to call by the name Māhārāṣṭra Apabhraṃśa⁹⁶. In two cases our present day Marāṭhī appears to draw from the Apabhraṃśa of the grammarians, the use of the interrogative particle *koṇa* from *kavaṇa* and the formation of the present participle like *karata jāta*. To this may be added the nominative singular ending *u* if we take the older stage of Marāṭhī into consideration. Beyond this there is no evidence to show that Marāṭhī has much to do with Apabhraṃśa as in the case of Gujarātī. The case of nominative singular can be explained as the weakening of the Māhārāṣṭrī termination. The peculiar Apabhraṃśa features like the formation of gerunds, the use of *ha* terminations in declension and conjugation, the retention of *r* in conjuncts are not found in

94. Journal Asiatique 1872.

95. Indian Antiquary Vol. XXX, 1901.

96. Ling. Surv. Introductory.

Marāṭhī. On the contrary in all these cases Marāṭhī follows closely the Māhārāṣṭrī Prakrit. Further as the old Marāṭhī words in *y*, *v*, and *h* do not show the nominative ending *u*, it is more probable to regard it as a case of weakening. Another suggestion is made to the effect that there was only one Apabhraṃśa from which all the vernaculars are derived. On the whole the available evidence is favourable to think that Marāṭhī is directly descended from Māhārāṣṭrī without the intervention of the Apabhraṃśa stage, unless we like to call the works in old Marāṭhī to be written in a Māhārāṣṭra Apabhraṃśa.

MĀHĀRĀṢṬRĪ LITERATURE

By a comparison of Māhārāṣṭrī with other dramatic Prakrits it becomes apparent that it stands on a different basis than the other Prakrits. It is a language primarily used to write works of the nature of artificial epics while its role in the drama is, after all, secondary. In fact speaking strictly this language is not a dramatic Prakrit at all. Like others it was not found in the Sanskrit dramas from the very beginning but was introduced later probably at the time of Kālidāsa. The reason appears to be the prominence in which it was held in other departments of literature. Another distinction between the dramatic Prakrits and Māhārāṣṭrī appears to be while other languages are restricted to the use in the dramas Māhārāṣṭrī is found in other than dramatic literature in its real importance. This literature is vast and of great value to merit detailed consideration.

THE SATTASAI OF HĀLA

The *Sattasaī* or *Gūhāsattasaī*⁹⁷ which is its fuller name, is an old anthology of Māhārāṣṭrī verses in the gāthā metre and amounting to some seven hundred pieces. It is traditionally attributed to a king Hāla or Śātavāhana. It is the most famous and best known of the Māhārāṣṭrī works. Its value as an anthology is fairly high and it also affords good historical evidence to show that Māhārāṣṭrī literature was once very extensive and wide-spread. Its popularity can be easily seen from the good number of commentators and the vast amount of quotations from it in later works on poetics, as well as the use made of it by the Prakrit grammarians. Bāṇa⁹⁸

97. Weber first edited the 370 verses under the title *Über das Saptasatakam des Hala*. Leipzig 1870; Some additions were made in Z. D. M. G. 26, pp. 725 foll. Later on a complete edition was given as *The Saptasataka des Hala*. Leipzig 1881. About Bhuvanāpala's recension Indi. Stu. 16. With the commentary of Gaṅgadharaḥṭṭa edited in KM. 21. A new edition by Mathurānātha with his own Tikā.

98. *Harṣacarita* v. 13

bestows on it high praise in the introductory verses of his *Harṣacarita* and Govardhana thought it suitable to compose a Sanskrit *Āryūsaptaśatī* on its model. Besides it gives us useful information of the rural and rustic life of the Deccan and reveals in a charming manner their proverbs and sayings current among them.

The work is divided in seven Śatakas or collections of hundred verses each, which however differ very much in various Mss. preserved to us. This Prakrit anthology is mostly of erotic contents, love in its various phases and stages being the dominating sentiment either of the writers themselves or of the taste of the collector. The Indians have notably developed greatly in the composition of gnomic poetry with a peculiar force of its own. These ancient Indian poets were masters of this art which produces pictures in a few broad and bold strokes giving us a small incident or a miniature picture complete in itself. The present collection contains many such master-pieces which depict village life. The chief feature of the present work is that it mainly occupies with the painting of the village life and the peasantry more than the highly polished and sophisticated living of the courts and palaces. Naturally it is rich in pictures of nature cottages, country-side gardens, fields, thickets forests, rivers, streams and mountains, animal and plant worlds, and other things essentially rural. The family life of the lower society is given from all possible points of view but the main stress lies on the erotic side. The commentators, however, coming as they do in an age fully dominated with the irresistible force of theoretic considerations, try to take almost all the verses as erotic in sense and this they are able to do with that much-valued suggested sense. In the majority of cases their interpretation is justified, but in this absurdly consistent procedure of theirs they appear to lose sight of the real meaning of the poet when they come to see in verses dealing with the other sides of village life, studies of nature pictures and simple animal behaviour the same suggestion of illicit love when no erotic contents can be reasonably seen in them. All this should not lead us to think that the present work is wholly devoted to the treatment of village life and nothing else. There are verses about other topics as well and in the traditional list of poets we find a few names of kings and famous court poets.

The scope of the anthology is extensive and deals with varied subjects drawn from different walks of life. Winternitz⁹⁹ would not like to call them specimens of ancient songs of the Indians

99. Geschichte der indischen Literatur pp. 97-104 of Vol. III.

dealing with the joys and miseries of their lives, but only artistic poems closely modelled on them, because he suggests that Prakrit was not the language of the people but a refined and literary vehicle of expression based on such a dialect. Most of the verses are detached and self-sufficient but in few cases two or three verses relate to one topic.

The majority of the verses deal with the love of the village maidens and youths, shepherds and hunters, and even common labourers. In few words and in an admirable way a tune is struck, a pain is sounded or a joy is pictured. Very often a brief picture of a labourer is given in a single verse. We often hear the lamentation of a love-lorn lady, her longings, her plaintive notes on her situation, her misery and pain of separation to which she sometimes gives vent. The usual conventions of Sanskrit poetry are also followed. As usual the winter season brings the lovers together while lightning and storm make the beloved to embrace him. The wishes of a lady in love are well expressed. She desires the moon to touch her with the same rays with which he has touched her lover, and wishes that night should last perpetually because her husband is going on a journey on the next day. A traveller prays that rain and wind should strike him as hard as they can but spare his beloved at home. The onset of the rainy season enkindles the flame of love in the hearts of lovers. The poets also describe in minute details the varied effects of love when he points out that one looks deeply into the eyes of the other and drinks with them. The beauty of the ladies is also described in a microscopic manner, in which every one of their limbs gets its due share. Many times the poet gives us situation not without a comic effect as when the boy climbs the back of his father when he falls at the feet of his wife¹⁰⁰.

Next to these come the pictures of nature. In four short lines the poet can effectively conjure before the eyes of the readers various scenes of the seasons, summer, autumn, winter and rainy-season, by pointing out their striking features. Winter lays bare the fields of corn while the summer burns them down. Equally fine are the pictures of animals, bees hovering round flowers, the peacock and the crow enjoying the rains, the antelope and his mate loving each other and rubbing with their horns, the female crane sitting silently on a lotus leaf and the many pranks of apes. Besides these the plants get their share and the mountain Sahya with the river Godā figures prominently. There are a

100. Keith; *History of Sanskrit Literature* pp. 223-235.

good many maxims and popular sayings of a gnomic nature while incidentally many gods, situations from the epics and folk-lore are also mentioned.

The work also gives us a few references of general interest. Of kings we meet the two famous names of Vikramāditya and Śālāhaṇa, beside the name of Hāla the compiler of the anthology at the beginning and the end of the Śatakas. The geographical atmosphere of the work is pretty old. No big towns are mentioned which may be due to the rural background of the work. The constant reference to mount Sahya and the river Godā makes it almost certain that the work is the production of the country of Mahārāstra. The winds from Malaya¹⁰¹ also play their part and the rivers Revā¹⁰² and Tāpī¹⁰³ on the northern side get mentioned. A few names of races and tribes like Pulinda, Palāśa and the Rākṣasas from Laṅkā occur. Of religious and mythological allusions, we have the praise of Śiva at the beginning and at the end under the title of Paśupati which would indicate that Hāla was a worshipper of Śaṅkara. He is once mentioned by the name of Pramathādhipa¹⁰⁴ which also occurs in Varāhamihira. His spouse Gauri and her temple is also referred to, while she is known by her popular names Ajjā¹⁰⁵ and Avaṇṇā¹⁰⁶. Kāpālīka¹⁰⁷ a worshipper of Śiva is also described as besmearing his body with ashes. Once Gaṇapati¹⁰⁸ is referred to, but the reading is doubtful. Viṣṇu¹⁰⁹ also figures and mention is made of his three steps in the heaven while his wife Lakṣmī is said to come out of the milkly ocean. The binding of Bali by him is also found in the *Mahābhāṣya* of Patañjali. Kṛṣṇa¹¹⁰ often figures. His play with the Gopīs in the Vraja are described and his beloved Rādhā finds mention. He is called Damodara which epitomises one of the incidents of his childhood. Madana¹¹¹ and his five arrows are prominently found. A few epic references occur. The death of the lord of the Kurus¹¹² at the hands of Bhīma in the presence of Mādhava is from the Mahābhārata while Rāma

101. 97,443.

102. 579.

103. 239.

104. 448.

105. 172.

106. 467.

107. 408.

108. 403.

109. 411, 338, 406, 425.

110. 657, 112, 87.

111. 545, 549.

112. 443.

and his brother Lakṣmaṇa are from the other epic¹¹³. Buddha¹¹⁴, his Saṅgha and their formula of greeting *siddhirastu* show the knowledge of Buddhism and possibly of Jainism.

But many of these references depend upon the different recensions of the work. There are at least six different recensions¹¹⁵ which differ from each other not only in the number of verses but also in their arrangement. Verses common to all the recensions amount to nearly 430 which can, therefore, be regarded as the oldest nucleus of the collection. The first recension is the common version which lies at the basis of the four commentaries and many Mss. of the work and called the Vulgate. It is commented upon by Kulanātha, Gaṅgādhara and Pīṭāmbhara and there is also an anonymous comment on it. The second version accompanied by another commentary agrees with the first in many respects except in case of the last Śataka where it differs greatly from it. The third one is much nearer the Vulgate but differs in the arrangement of the gāthās and the choice of the readings. The fourth recension on which is found the commentary of Śādhārāṇadeva and the fifth preserved in Telugu Mss. give very different appearance. The sixth one agrees with the first three in all respects as regards arrangement but shows different contents. Even then, from the quotations found in the works of poetics which are absent from all the recensions it appears that the work was also found in other recensions as well. All these divergences can only be explained by supposing that the collection was originally a self-standing but much smaller one and was later expanded and supplemented by successive copyists and redactors who added verses from different sources which they liked and appreciated. But then we have to suppose that the collection got its present name much later.

The third verse at the beginning says that the present collection of the 700 gāthās is taken out of a crore of such verses by Hāla and all the recensions have the same verse. According to Hemacandra¹¹⁶ Hāla is the same as Śātavāhana, Śālāhaṇa or Śālivāhana one of the Āndhrabhṛtya kings of Deccan. One tradition says that the goddess of learning Sarasvatī once lived in his house for a day and half and inspired all the inhabitants of the town even including the elephants and horses so that they

113. 35.

114. 308.

115. Weber p. XXVII.

116. *Abhidhānamālā* 712 *Deśīndramālā* 294.

composed Prakrit poems out of which Hāla made the present collection of 700 gāthās.

It is obvious that the present selection is taken out of a rich literature lying at its background and current at the time. Unfortunately we have no very authentic tradition preserved to us in giving the names of the poets to whose credit the gāthās are to be assigned. The commentators have preserved no doubt names but its value is greatly lessened by their disagreement. The Vulgate mentions 112 poets while Bhuvanapāla has as many as 384 names who contributed to the anthology. Even in individual cases the four commentators of the first recension do not agree in attributing the verse to a particular poet which makes their information of no great value if not absolutely worthless, as thought by Keith. Pischel¹¹⁷ has on the other hand taken a sympathetic view in accepting it with some reservations. The names preserved include Śalivāhana, Hāla, Voḍisa, Triloka, and a few names of ladies like Revā, Nāthā, Prahatā etc. If we believe a verse in the work to be authentic we have to say that each verse in the collection bears the name of the poet, which, however, is not the case at present. Even then, we need not suppose that the names are pure fiction and invention of the commentators. Of the few we know something from other sources as well. Harivuḍḍha and Poṭṭisa are referred to by Rajaśekhara in his *Karṇāramañjarī* in close association with Hāla while Bhoja quotes a verse in which Hāla is put as an ancient poet along with Haricandra. Pālia is better known as Pādalipta while Aparājita is said to be the author of *Mṛgāṅkalekhākathā*. Pravarasena is famous. Even though these poets are well known and must have written in Prakrit the allotment of the verses from the anthology to them remains doubtful.

It is difficult to evaluate the exact nature of the work of Hāla, the redactor of the collection. It is pointed out that all the verses bear a good deal of similarity with each other which would lead one to think that Hāla played not only the role of a redactor but also something of the nature of a composer and reviser who brought all the previous verses to a particular standard and a definite form¹¹⁸. This, it is suggested, is the import of Bāṇa's statement and the meaning of the third verse. Hāla not only collected these verses but gave them a literary form. From this fact and from the evidence that only a small number of verses are

117. Gra. Pra. Spr. Sect. 13.

118. Winternitz. p. 101.

common to all the recensions, Keith suggests that *Sattusaī* was originally no more an anthology but a collection of verses largely his own and refashioned by him which in course of time by being extensively interpolated got its present shape of an anthology and suffered much in its individuality.

The Indian tradition dating as early as the time of Bāṇa and Daṇḍin attributes it to Hāla who is identified with the king of the Āndhrabhṛtya dynasty which ruled over Deccan with their capital at Pratiṣṭhāna from the third century B.C. to the middle of the third century A.D. Hāla comes in the middle and is said to be the 17th king and is assigned to the first century. This procedure, Keith calls as mechanical and without any foundation. From the Purāṇic tradition and the inscriptions at Nāśik we know that Sātavāhana was the name of the family and its greatest prince Gotamaṃputra Śātakarṇi is assigned to 319-340 A.D. by Bhandarkar. According to these traditions the whole dynasty lasted for 456 years. The *Mastya* assigns Hāla to 297 years after the beginning of the dynasty. Lassen has put him about 276 A.D. Haraprasad Shastri¹¹⁹ remarks that Hāla cannot be placed later than the first century A.D. and the mention of a Vikramāditya in the *Sattasaī* should be synchronised with the founder of the Samvat era. There are a few facts which favour this conclusion. From *Bṛhatkathā* and other traditions preserved in *Kāmasūtra* and *Kāvyamīmāṃsā* we know that the Sātavāhanas were in favour of Prakrit which is corroborated by their inscriptions at Nāśik. The geographical background of the work also points to the country where these kings ruled.

Weber¹²⁰ however points out that in verse 467 we find king Sālāhaṇa mentioned as a great person which makes it impossible that the work is contemporary with him. It is also doubtful whether both Hāla and Sālāhaṇa are identical. From the internal references Weber thinks it clear that the anthology cannot be earlier than the third century A.D. This conclusion, Weber thinks, is confirmed by the political, geographical, religious and other allusions found in the work and is further corroborated by the evidence of the language. He points out that the two words Vandī¹²¹ and Horā, the word Aṅgaravāra¹²² to mean Tuesday all showing acquaintance with Greek astronomy show that the work is late. The absence of the name of Kālidāsa in the list of the names of the

119. *Epigraphica Indica*. XII, 320.

120. p. XXIII.

121. 435.

122. 267.

poets, he is inclined to interpret, as favouring this date. But much of the force of his arguments is lost, when we remember that Sālāhana is the name of the Dynasty and that the anthology has suffered greatly while attaining its present form.

Jacobi, on the other hand, had identified this king Hāla with the Sātavāhana king of Pratiṣṭhānapura who, at the advice of the sage Kālīka, changed the date of Pajjūsāṇā of the Jains in 467 A.D. This date agrees well with all the allusions in the work. But it is very doubtful whether the Jains are right in putting the Sātavāhana king so late and their tradition itself is not of great value. Keith stresses the point that the language of the present anthology is later than the dramas of Aśvaghōṣa and the inscriptions of the early Christian era, which would induce him to place the production of the poems between 200 and 450 A.D. and their putting together in the form of an anthology somewhat later. From the evidence that is available it is most probable that the work belongs to the first century A.D. and is closely associated with the Sātavāhana kings.

From the majority of the verses in the collection it is evident that Hāla collected his pieces from a literature essentially of the same nature, stray verses dealing with complete situations. But even then a few gāthās would indicate that they are taken from popular tales like that of a lady put in captivity but waiting to be released, a woman captured by thieves or the unchaste woman who pretends that she is bitten by a scorpion because she wants to go to the house of the doctor whom she loves. But even this cannot be said to have some context as the situations can be easily imagined for the purpose of understanding the verses.

It is usually difficult to judge the style and poetic excellence of an anthology. The gāthās being from very varied hands are of very diverse characteristics. But what strikes one in this case is not their differences as their similarity which is explained on one theory as due to the redaction of Hāla. Speaking generally we find the style of this collection homely and simple and stands in glowing contrast with the style of the later epics like *Setubandha* and *Gaiṇḍavaḥo*. Very scarcely have the authors taken recourse to scholarly devices of making good poetry, such as play on words and recondite allusions. The poets here appear to express their ideas in as direct a manner as possible and this gives their work a peculiar charm. It has a very close connection with the realities of life and a still closer association with natural things which can scarcely be met with in Sanskrit works. They show a certain amount of frankness and rough good sense in dealing

with love, while quaint expressions of women would indicate the provincial mode of expressing things. The language is purely Māhārāṣṭrī with little mixture of other Prakrits. The work, however, abounds in many Deśī words and the majority of them are found in modern vernaculars especially Marāṭhī.

THE HARIVIJAYA OF SARVASENA

Sarvasena appears to be one of the ancient writers in Māhārāṣṭrī and of considerable repute. Unfortunately we know nothing about him or his Prakrit epic *Harivijaya*. All that we can get to know of him is from later references in the works of Sanskrit rhetoricians. Of them the *Dhvanyāloka*¹²⁴ is the oldest to quote from it. A few quotations are also found in the two works of Bhoja, the *Sṛṅgūraprakāśa*¹²⁵ and the *Sarasvatīkaṇṭhābharana*¹²⁶. In all we have some ten or eleven verses from the work.

The verse from the *Dhvanyāloka* describes the beginning of the spring in which the god of love takes hold of the face of the goddess of vernal beauty. Another describes the beginning of anger in the heart of Satyabhāmā, one appears to embody the words of Kṛṣṇa consoling his beloved who had grown angry for the sake of the heavenly flowers, a third describes Rukmiṇī who was greatly delighted at the sight of her husband even though the occasion was one for getting angry. In a verse anger pervading the face of Satyabhāmā is described as charming like the spot on the disc of the moon, while another delineates her face on the verge of getting delighted and the anger passing off being overcome with delight. A few verses give us the reconciled state of the heroine when her desire of getting the heavenly tree was fulfilled.

From these few quotations it is sufficiently clear that the subject of the epic was the famous episode in Kṛṣṇa's life, his conquest of Indra for the sake of the flowers of the heavenly tree Pārijāta to satisfy the desire of his beloved Satyabhāmā who was roused to jealousy on account of his having given her co-wife Rukmiṇī a garland of the flowers of the same tree. As all the quotations are found in one and the same metre it is but natural to suppose that the authour wrote his epic in the Skandhaka as is the case with the work of Pravaraṣena, even though it is just possible that others were sparingly used. From

124. KM. p. 127, 148.

125. 22, 43; 22, 79; 23, 73.

126. pp. 647, 655, 673, 678, 724, 727.

a remark of Abhinavagupta¹²⁷ in his comment on the *Dhvanyāloka* it appears that this epic contained the episode of the taking off of the Pārijāta tree as something that is invented by the poet though not found in the sources, and being made subservient to the purpose of reconciling his wife. This would make one think that the main theme of the epic was something different and of greater importance.

In the absence of any more evidence it is not possible to determine the date of our author. If we believe the statement of Bhuvanapāla¹²⁸ that many verses in the *Sattasaī* are from his pen, we will have to place the author fairly early. But much reliance cannot be placed on him unless corroborated by other evidence. At any rate he is earlier than Ānandavardhana and must have lived a few centuries before him.

For all that we know Sarvasena appears to have written in a charming style marked with great delicacy as remarked by Kuntala¹²⁹, his work being an illustration of the Sukumāramārga in poetry and this is fully borne out from the few quotations we now come across. His language is easy and less complicated than that of Pravarasena. But he also shows the use of long compounds and poetic figures. He is also fond of giving gnostic sayings and in all these things there runs a close parallelism between his work and the *Setubandha*, producing a strong suspicion of one being the model of the other. Yet their precise relation would remain doubtful unless we are able to determine the relative chronology of the two authors which it is not possible with the material at present available.

THE SETUBANDHA OF PRAVARASENA

The *Setubandha* of Pravarasena¹³⁰ is one of the early epics written in this Prakrit. From the text itself we come to know that the author called the work *Dahanuhavaho*¹³¹ or *Rūvanavaho*¹³² and it is marked by the presence of the word *Aṇurūa* at the end

127. *Dhvanyāloka* p. 148 Com.

128. Weber's edition of *Sattasaī*.

129. Kane; Introduction to *Sahityadarpana*, p. LXXXVI.

130. The first two chapters were edited by Paul Goldschmidt. A complete edition was brought forth by Siegfried Goldschmidt with a German translation and a word index in collaboration with Paul Goldschmidt. Strassburg 1880-1884. It is edited in *Kavyamālā* No. 47 with the Sanskrit commentary of Rāmādāsa and a Sanskrit rendering by Sivadatta and Parab, Bombay 1895.

131. 1, 12

132. XV, 95

of each chapter as do many of the Mahākāvya in Sanskrit¹⁸³. But from the references to our work by such early writers as Bāṇa¹⁸⁴ and Daṇḍin who lived soon after the poet we know that the epic also had the title *Setubandha* which was popular enough to admit of a pun. That name is no doubt applicable to the work with sufficient accuracy because the major portion of it is devoted to the description of the building of the Setu or the bridge over the ocean by the monkeys, while the historical allusion to the building of the boat-bridge over the river Jhelam¹⁸⁵ by the author must have helped it to get greater currency. The original name *Rāvaṇavaho* must have been also current for a long time as can be inferred from the fact that the Prakrit epic of Vākpatirāja styles itself *Gaudavaho* no doubt after the manner of the present one.

Tradition attributes this work to a king called Pravarasena and this is borne out by many facts. Both Daṇḍin and Bāṇa refer to him as its author, and still later Kṣemendra¹⁸⁶ quotes a verse as being the composition of Pravarasena which is to be found in the *Setubandha*. At the beginning of the work we find the expression 'begun by a king'¹⁸⁷ applied to the book.

But some doubt is cast on this tradition by the curious colophon found at the end of each Āśvāsaka which runs "ia siripa-varasenaviraie kālīdāsakae mahākavve pañcaraho āsāsao parisamatto"¹⁸⁸, while the commentator Rāmadāsabhūpati who lived in the 16th century refers to this tradition of the composition of Kālīdāsa¹⁸⁹. But his further remark that Pravarasena may be the same king as Vikramāditya or even Bhoja shows the extremely confused nature of this tradition even at that early time and so appears to be a pure later invention to father one of the greatest Prakrit epics on the famous poet Kālīdāsa. It is impossible to explain if the work really belonged to Kālīdāsa, how Bāṇa never knew this fact and how on the contrary he definitely attributed it to king Pravarasena unless there was some genuine tradition current at his time. From verse nine it is just possible to argue that the work was the composition of some court poet of Pravarasena and

133. cf. XV, 94-95. Kirāta has the word *Lacmī* and Māgha the word *Śrī*

134. *Harṣacarita*, Introductory verse 15. Cp. Peterson, *Kādambari* Introduction pp. 77 ff.

135. *Rājatarāṅgiṇī* III, 97 ff.

136. In his *Aucityavicitracarā* he quotes *Setubandha* IV, 20. *Kavyamala* Part I, p. 135.

137. 'ahīṇavardāraddhā' 1, 9.

138. *Kavyamala* ed. p. 497.

139. *Ibid* pp. 3, 10.

was made current by the name of the patron¹⁴⁰. This will also explain to a certain extent the fact that the work was later attributed to Kalidāsa as soon as the real author was forgotten. At any rate both the style marked by long compounds, elaborate puns, strained imagery and the form of the work showing no skill in the arrangement and heedless of repetition both of ideas and of situations would make it extremely improbable that it is from the pen of Kalidāsa.

Whoever be the actual writer of the epic, and we have no means to know him, it is clear that it was composed at the time of Pravarasena with whose name it has become early associated. Naturally the date of the work can be ascertained by the determination of that king's reign. In the early history of India there are four Pravarasenas belonging to two different dynasties. Two of them belong to the list of the Kāśmīrian kings and are mentioned in the *Rājatarāṅgiṇī* of Kalhaṇa¹⁴¹. The other two belong to the less known Vākāṭaka family which flourished in Deccan in the 4th and the 5th centuries¹⁴².

It appears very probable that the present epic was written in the reign of one of the Kāśmīrian kings and particularly in the reign of the second Pravarasena of that line. According to the calculations of *Rājatarāṅgiṇī* which Pandit¹⁴³ accepts as true and defends at great length the first Pravarasena ruled from A.D. 58 to 88 A.D. and the second from A.D. 125 to 160 A.D. If we are to accept these dates as true the work would fall in the second century A.D. at the latest. But according to the modified calculations of Stein¹⁴⁴ who is followed by many others in this respect the second Pravarasena is to be assigned to the 6th century and consequently that will also be the probable date of the epic. From the style of the poem and its close dependence on Sanskrit literature of the 6th century more than of the second we think the later date to be nearer the truth.

There is another tradition which is referred to by Rāmadāsa at the beginning of his comment, according to which the work is put to the credit of Kālidāsa who wrote it for king Pravarasena at the behests of Vikramāditya Chandragupta the second. In recent times¹⁴⁵ this theory is revived and new evidence to substantiate it

140. Cp. Winternitz, *Gesch. Ind. Lit.* p. 63 n. 3.

141. Chapter III.

142. cf. The inscription of the Vākāṭaka kings. IA. XII, p. 243.

143. Introduction to *Gauḍaraho*. pp. clxi-ccv.

144. M.A. Stein, *Rājatarāṅgiṇī*, Tr. Vol. I, pp. 66, 84ff.

145. Cp. Rāmasvāmi Shastri, 7th Oriental Conference. Baroda.

is sought for. Great stress is laid on the fact that the curious colophon at the end is found in all the Mss. of the work so far available and therefore must possess some old and genuine tradition. A verse ¹⁴⁶ from the first chapter also suggests that the work was not the composition of Pravarasena alone; he only began it and was completed by somebody else. Now in a tradition preserved in a work called *Kuntaleśvaradautya*¹⁴⁷ of which we have a few quotations only, there is mention of king Vikaramāditya who is no other than Candragupta the Second of the imperial Gupta dynasty as being connected with the Vakāṭaka family as his daughter Prabhāvatīguptā was given in marriage to Prthvisena the First. It is further reported that Kālidāsa was sent by him to this king as an ambassador and must have helped Pravarasena the Second, the son of Rudrasena in composing the present epic, a fact which would explain the colophon and the tradition preserved by the commentator.

There are real difficulties in accepting this theory of the authorship of Kālidāsa in collaboration with the Vakāṭaka prince Pravarasena. It is more than doubtful whether the work *Kuntaleśvaradautya* had any historical veracity to base ones conclusions on it. We know too little of Kālidāsa to judge his character as an emissary in bringing the two royal families together. The identification of Devagupta, the father of Prabhāvatīguptā with Candragupta, though usually accepted, is not beyond doubt and the few glimpses of the lost work do not give us the tradition clearly. The nature of the language and the inordinate desire of the author to form Yamakas and the older tradition preserved by Bāṇa would force us to reject this suggestion.

The work is handed down to us in three different recensions which do not differ much from each other. The most authentic one is the one preserved by Rāmadāsa who wrote his commentary in A.D. 1596¹⁴⁸ at the time of Akbar. Another recension is preserved by the commentator Kṛṣṇa who is later than Rāmadāsa as is clear from his introductory remarks and his criticisms of his explanations. The difference between the two recensions lies in the fact that while Rāmadāsa has 15 Āśvasakas, Kṛṣṇa has 16 which he makes up by splitting the 13th chapter into two at verse 67. This arrangement, however, is not very consistent as the characteristic word Anurāa is not found in that verse. The third is not exactly

146. 1, 9.

147. Cp. *Aucityavicāracaed.* p. 139 where the verse is attributed to Kālidāsa, also *Kāvyaśikṣasāra*, p. 60-61.

148. Cp. his concluding verses p. 497.

a version of the text but a free Sanskrit rendering prepared by one Śivānārāyaṇadāsa at the request of one Rāmasiṃha¹⁴⁹. It is not a word-for-word translation but follows the original verse-for-verse¹⁵⁰. Even the extra verses found in the different manuscripts come to only 14 and show signs of genuine composition.

The author opens the work with a salutation to Viṣṇu who is described as killing various demons like Madhu, Hiranyakaśipu, Aṛiṣṭha and others and his exploits like the bringing down the Pārijāta tree from the heaven. He also offers his obeisance to Śiva, his laughter and his dance. A few remarks on poetry and its difficulties are added and the author expresses his intention of composing his epic *Dahamuhavaho*.¹⁵¹

The story opens with the description of Rāma whose grief is aggravated by the coming up of the autumnal season and his lamentation for the loss of his beloved wife Sītā, who is taken off by the demon Rāvaṇa. The poet takes this opportunity of describing the Śarad at great length. At that very time Hanumanta comes back successful from his mission of searching Sītā and relates to Rāma the long awaited news about her and gives in token her crest-jewel. Rāma is greatly delighted at its sight but slowly his joy turns into rage towards his enemy Rāvaṇa, whom he now wishes to conquer by marching against Laṅkā. He crosses the mountain Vindhya and the army of the monkeys arrives on the shore of the ocean (i).

Rāma now views the vast ocean stretching before him and the poet picks up the occasion to display his power in describing the ocean in an elaborate manner which covers the major portion of the Āśvāsaka¹⁵². The effect of this obstacle in their way is very different on different persons, Rāma looking at it without much concern, Lakṣmaṇa not losing his courage, and Sugrīva looking at his army of the monkeys. But, the monkeys are disheartened at the unexpected difficulty and look admiringly towards Hanumanta who has crossed and recrossed it (ii).

Sugrīva now views his drooping followers and to put courage in them delivers his fiery speech in which he points out to them their duty and shows them the necessity of overcoming the obstacle, as death is far more preferable to infamy. This speech, however, has no effect on the army. Another speech is made in which he

149. Only the third chapter of this is published by Goldschmidt in his edition.

150. But in different metres.

151. I, 1-12.

152. II, 1-36 forming one big sentence.

promises to overcome the difficulty himself if his followers are not willing to take up the risk which enkindles the fire of heroism in the army. The whole of the chapter abounds in good many moral sayings¹⁵³ and maxims with appropriate illustrations from nature, which does credit to the author and more than justifies the remark of Daṇḍin that it is a veritable ocean of good sayings (iii). Now gets up Jāmbavat, the oldest in the army, with a long line of experience behind him, on which he harps so often, and who now tries to combat the agitation in the army with sober words, importing a slow and thoughtful action on their and on Sugriva's part and gives a real appreciation of the magnitude of the danger. He hints that Rāma is fully capable of subduing the ocean and suggests that the ocean itself should be requested to give a free path on its waters of his own accord. At this moment there arrives Bibhiṣaṇa from the sky, whom Māruti easily recognizes to be a friend and carries him to Rāma who greets him with praise and suggests that he will be made the lord of Laṅkā (iv).

The fifth chapter opens with the description of Rāma again suffering from the pangs of separation in the moon-light night, and early in the morning he makes his mind to chastise the ocean. He then hits it with his arrow which emits fire and thousand of other arrows from itself and plays havoc on the ocean and its aquatic animals. The author devotes the whole of this chapter to the graphic and minute description of Rāma's shooting the arrow and the plight of fishes, serpents and the surging up of the waves. The minuteness of the picture can be well imagined from the fact that 15 verses¹⁵⁴ are taken up by the mere shooting of the arrow (v). Being hit strongly the ocean comes up in a human form and along with his spouse Gaṅgā falls at the feet of Rāma whom he praises and argues that it is but at his bidding that he has kept the boundaries. He further suggests Rāma to build a Setu over its waters to cross them with ease. Rāma accordingly gives orders to build a bridge. The monkeys begin to pick up mountains to fill in the cavity of the ocean and a detailed description of it occupies the remaining Āśvāsaka (vi). Now the monkeys begin to work out the idea and throw big mountains in the ocean which make the water surge up high and disturb the ocean enormously. But after a long and strenuous exertion the ocean remains unfilled and the monkeys begin to feel a little exhausted (vii). They now stop their work for a moment as it is of no avail, and heap the mountains on the shore. Meanwhile the ocean regains its calm-

153. cp. III, 6, 8, 9, 10, 12, 13, etc.

154. V, 17-31.

ness. Sugriva now requests Nala to build the Setu so that Rāma should not find it necessary to string his bow once more and use his arrow for a second time. Nala promises to do the work and with the help of the monkeys succeeds in constructing the bridge which is now described at great length. The army now passes over the ocean with ease and arrives on mount Suvela on the other side. At the news of this wonderful feat of the enemy the demons lose their faith in Rāvaṇa (viii). The next Āśvāsaka is devoted to the description of Suvela in which the author shows his skill in the use of figures of word like Yamaka and Anuprāsa¹⁵⁵ which are taken to be signs of the poet's ability of wielding the language as he wishes (ix). Now follow the usual things to be described in a Mahākāvya like the setting of the sun, the approach of the evening, the spreading of the darkness, the rise of the moon and the sports of the ladies, love and its enjoyments (x).

The scene is now transferred to Laṅkā where we see Rāvaṇa suffering from the fever of love towards Sītā. He thinks of all possible ways of winning her over and finds no suitable means. At the end he hits upon a plan and calls his servants. He orders them to show to Sītā a false head of Rāma which they produce by their magical power. Sītā is described in her pitiable condition when they show her the false head of Rāma and swoons immediately from which she recovers only to fall into another. Then follows her pathetic lamentation and the consolation offered to her by her demon attendant Trijaṭā who points her out the falsity of the situation. This forms the best passage¹⁵⁶ in the whole epic (xi). The next Āśvāsaka opens with the description of the dawn when Rāma gets up and the army of the monkeys is prepared to fight. Rāvaṇa also is ready and his army is arrayed. While the demons are girding themselves up the monkeys lay a siege to Lanka. Now follows the encounter of the two armies on the battle-field (xii). The battle continues for a long time with victory inclining towards one side or the other in turn and the heroes of both the parties meet in individual duals and Aṅgada defeats Indrajit (xiii).

On the field now come both Rāma and Lakṣmaṇa and there arises a fierce combat between them and Indrajit, who however, overcomes them for a short time with the missile of the serpents. Both of them fall in a swoon to great grief in the army of the monkeys. But they soon recover and Rāma invokes Garuḍa to ward off the serpents. Individual combats between the heroes of both the armies go on in the meanwhile (xiv). One by one the

155. IX, 18, 43, 44, 47, 50, 82.

156. XI, 75-131.

leaders of the demons begin to fall. First Kumbhakarna is killed, Indrajit follows him and Ravana, enraged at the loss of his brother and son, hits Lakshmana with his irresistible power. Lakshmana falls in a swoon but soon recovers. Now follows a fight between Rama and Ravana wherein the latter is defeated and killed. Bibhishana laments the loss of his brother. After the battle Rama returns back to Ayodhya along with Sita who is purified in fire to satisfy the love of Bharata. The author then closes the epic which he names *Ravanavaho* and in which he has used the word *Apurāṇa* as a characteristic mark (xv).

In this epic Pravarasena shows all the equipments of a classical scholar composing a Mahākāvya. In the third and fourth chapters he shows his knowledge of the royal policy and depicts a lovely controversy about the respective merits of following the direct policy of proceeding against the difficulty and the sober method of inventing some device to overcome the same. Sugriva asks the monkeys not to wipe off their fame which he compares to a good person who is somehow come to make a request, both being difficult to be obtained once more¹⁵⁷. It is the duty of the lord to order while the real burden of the work falls on the servants¹⁵⁸. Battle and its hardships alone are able to distinguish between true heroes and those who pretend to be so¹⁵⁹. The words of Jambavat are equally weighty. He points out that dejection carries off fortitude, youthfulness removes modesty, and love takes off the sense of shame¹⁶⁰. What warriors in union can do can never be done by them individually which he illustrates by the fact that one ray of the sun may torment at the most, but all of them are able to burn the three worlds¹⁶¹. Energy misplaced proves neither effective nor dreads the enemy like the mistaken arrow shot in rage neither hits the mark nor produces fear¹⁶².

He is equally happy in describing the state of love in separation. The lamentation of Sita at the sight of Rama's head reaches the high water mark of the poet's ability in producing the sentiment of pathos. He is equally clever in giving a situation in as few words as possible. Sita was downcast when she looked at the false head, began to tremble when the demons pushed it before her, and instantly swooned when they said it to be Rama's head¹⁶³. Rama's

157. III, 4.

158. III, 6.

159. III, 8.

160. IV, 23.

161. IV, 28.

162. IV, 29.

163. XI, 52.

love towards Sītā is finely given¹⁶⁴. Rāma valued the southern quarter because she lived in that direction, the moon because she admonished her in her separation, the ground because she sat on it, and the sky because she was carried through it. A fine contrast is effected in the description of the words of the ocean¹⁶⁵ which were soft but able to bear the weight of their import, few but full of meaning, lowly but lofty with courage, obliging but true in sense. Equally concise is the description of the meeting between Rāma and Hanumanta, when told that he has seen her (Sītā) he did not believe it, when told that she was emaciated he sighed slowly with tears, when told that she laments he cried, and when told that she lives he embraced Māruti¹⁶⁶. Sugrīva, when he sees that the bridge is not at all visible even when so many mountains are thrown in it, requests Nala in plaintive terms 'the monkeys are exhausted, the earth has only a few and far off mountains, nor is any trace of the bridge to be seen, but let not the mighty bow of Rāma be bent once more'¹⁶⁷.

The work is divided in 15 Āśvāsakas and contains on the whole 1362 verses. The prevailing metre is Skandhaka, a mātrāvṛtta having 32 syllables in each of its two feet and divided into four feet of four mores each. At the end of an Āśvāsaka and sometimes even in the middle other metres are found used most of them found in Prakrit poetry alone. Next to Skandhaka comes the Galitaka¹⁶⁸ occurring 32 times and Anuṣṭubh¹⁶⁹ only four times, while there are three metres¹⁷⁰ unknown from other sources.

The work is beyond doubt written in the Māhārāṣṭrī Prakrit and quotations from it in the grammars of Hemacandra¹⁷¹ and others go to support it. Daṇḍin explicitly says that the *Setubandha* is written in it. This is also in conformity with the rules of the rhetoricians who assign this Prakrit for the writing of the epics. In one point however, the text shows forms which are not in agreement with the rules of the grammarians. Goldschmidt says¹⁷² that here and in cases like them we should give greater

164. V, 6.

165. VI. 9.

166. I, 38.

167. VIII, 14.

168. II, 24, 27, 31, 33, III, 45-47, VI, 48, 53 etc.

169. IX, 43, 44, 47, 50

170. VI, 65, VII, 59, 61.

171. Cp. above note 35.

172. His preface to his edition.

weight to the authority of the Mss. than the rules of the grammarians. It is true that Hemacandra's grammar is older than all the Mss. of the work so far available to us, and more so in case of his predecessor, but it is doubtful whether we should follow them completely in restoring texts older than themselves. In many cases where there is a discrepancy between the readings of the texts and the rules of the grammarians it is usually the mistake of the copyist but in few the Mss. tradition is better and such appears to be the case in forms like *udu*, *dāva*, *mailida*, *vivaṇṇadā*, and *Rāmādo*. It is worth noting that in all these cases Vararuci¹⁷³ gives these forms as correct even though Hemacandra and others would bar them.

As remarked by Winternitz¹⁷⁴ the present work is written for a public which was well versed in Sanskrit. Naturally the language is greatly influenced by the Sanskrit style and conventions. Out of the three-fold division of the Prakrit vocabulary the major portion of our work is made up of Tatsama and Tadbhava words, the latter far exceeding the first. But the author is also influenced by the popular literature before him and so a small number of Deśi words is found in the epic. If we accept further the fine distinction between the Dhātuvādeśas and the Deśi words which consists in the fact that while the former can be traced to a great extent in the vocabulary of the modern Indian languages the latter do not admit of such a ready recognition, we have in *Setubandha* the words of the former class only¹⁷⁵.

The style of the epic is strongly influenced by the style of the famous Sanskrit epics. As a result we find the use of long compounds and elaborate puns to be met with on every page. The author cares more for the Yamakas and Anuprāsas and figures like Upamā and Utprekṣā are based on Śleṣa¹⁷⁶. Much need not be made of such defects as almost all of them were highly valued at that time and it is but natural that the writer should be guided by the taste of his days and should try to show his skill in excelling in them. Even then the epic shows considerable power of poetic merit and comes up to the rigorous standard of a Mahākāvya. Pravarasena's style is full of beautiful expressions, charming alliterations and strikingness of thought and imagery. With all the artistic pomp in style and language

173. Vararuci II. 7.

174. Gesch. Ind. Lit. p. 64.

175. cp. *guppanti* I, 2; *volīṇam* I, 3; *khudio* I, 4 etc.

176. Cp. II, 10; III, 5 etc.

we find real sentiment running as an undercurrent throughout the book.

There arises the question of the use of Prakrit in a work of this nature. It has the same style and artistic nature as that of Sanskrit epics and it is difficult to believe that it was written for some other public than the one to which Sanskrit epics were addressed or to regard it as strictly popular works. It is just possible to think that in the court of king Pravarasena Sanskrit was of less concern than Prakrit. But a truer explanation would be to suppose that the author thought of showing that one can overcome all the difficulties of a different language and is able to produce a work claiming comparison with famous Sanskrit epics. The epic got new interest in it at the time of emperor Akbar and his son Jehangir.

THE GAUḌAVADHA OF VĀKPATIRĀJA

The *Gauḍavaho*¹⁷⁷ of the poet Vākpatorāja is an epic of some historical importance. Vākpatorāja was a court poet of king Yaśovarman of whose conquest the poet supplies us information, though meagre. The work is a semi-historical poem written in the gāthā metre numbering over 1200. It has no divisions and is written in a continuous form. As the name indicates the subject-matter of the poem is the defeat and death of king of Gauda at the hands of the hero, the king of Kanauj. Unfortunately the name of this Gaudian king is not preserved to us.

The poet begins with his salutations to the deities of the Hindu pantheon which includes Brahmā, Hari, his various incarnations, Śiva, his spouse, Sarasvatī and others¹⁷⁸. Then follows a group of verses dealing with general topics like poetry, former poets, wherein the Prakrit language receives high praise and some good remarks on poetry are given¹⁷⁹. Then begins the real theme of the work and king Yaśovarman is praised with the usual lavishness of a court poet but with real poetic flight of his imagination¹⁸⁰. Then follows the description of the effects of this king on the minds of the ladies of the town who flock to see him issue forth out of his capital¹⁸¹, his greatness leading to the

177. Ed. by S. P. Pandit in BSS. 34. Second Ed. by N. B. Utgikar, 1927. The edition contains the comment of Haripāla.

178. Gāthās 1-61.

179. 62-98.

180. 99-108.

181. 109-113.

astonishment of Indra¹⁸², and his sports in water¹⁸³. This portion of the poem contains the digression of the exploits of Indra in cutting the wings of the mountains which formerly flew through the sky to great inconvenience of all. The author has further introduced the description of the time of universal destruction of the world with the simple device of identifying the king with god Hari¹⁸⁴.

Now in winter Yaśovarman starts on his expedition of the conquest of the world. His sight affects the ladies of the town¹⁸⁵ and even the damsels of the heaven with the passion of love. Then follows a long but beautiful praise¹⁸⁶ put in the mouth of his bards which once more repeats the incidents of cutting the wings of the mountains. His army of the horses and elephants is described at great length¹⁸⁷. In the Hemanta season he arrives on the banks of the river Śona, and his warriors wander at pleasure in the fields which are painted with a keen observation of nature and a first hand knowledge of the rural life¹⁸⁸. He then arrives on mount Vindhya where he is led by a forester to the temple of the goddess Durgā whose praise¹⁸⁹ forms a good hymn in the mouth of a king, and who receives a long eulogy. Then follows a very slight reference to the flight of king of Magadha who is afraid of Yaśovarman. His followers, however, offer a fight and are easily defeated¹⁹⁰.

Then follows a description of summer¹⁹¹ and a brief statement that the Gaudian king is killed by Yaśovarman¹⁹². He then proceeds to the shore of the ocean. He defeats the king of Vaṅga¹⁹³, receives submission from the king of the southern country, and goes to the south ocean. At this point the author gives the description of the incidents in which Vāli takes hold of

182. 114-160.

183. 161-166.

184. 167-181.

185. 202-207.

186. 212-254.

187. 255-262, 263-269.

188. 270-279.

189. 285-338.

190. 348-354.

191. 355-382.

192. 414-417.

193. 419-491

Rāvaṇa¹⁹⁴. Yaśovarman then conquers the Pārasikas in a hard-fought battle¹⁹⁵.

The author again introduces the description of the acts of king Prthu who pushed the mountains on both the sides with the bow¹⁹⁶. Now the king arrives on the bank of Narmadā which gives the opportunity of describing the love of the river for Kārtivīryārjuna¹⁹⁷. He then wanders in the deserts of Maru. He arrives to the country of Śrīkaṇṭha and a description of the sacrifice of the serpents is given¹⁹⁸. He laments over the hard fate of Duryodhana when he arrives on the battle-field of Kuru¹⁹⁹.

After this long march of the conquest he returns back to his capital. This opportunity is utilised by the poet to give a long and brilliant picture of Yaśovarman's sports in water and the beauty of the ladies²⁰⁰.

From this main theme of the work the author again turns to the praise of a few poets of old times and the occasion of the composition of the present work²⁰¹. The learned people wish to hear Vākpati compose a poem dealing with the exploits of king Yaśovarman who is no other than an incarnation of god Hari. The occasion of Yaśovarman's coronation gives rise to the description of incidents like Prthu's stabilising the earth²⁰², the churning of the ocean²⁰³, and many other mythological incidents. The poet promises to give out his poem in the next morning which is followed by a glowing picture of the rising sun²⁰⁴. The work is brought to a close with the remarks that the poet begins to give to the audience his big work dealing with the life and the conquests of the king which he requests the people to hear²⁰⁵.

From this brief review of its contents it is clear that the work has little historical interest and throughout are scattered the descriptions of mythological incidents, which, on the whole, outweigh the frame-work of the poem.

194. 424-430.

195. 431-439.

196. 440-459.

197. 460-465.

198. 472-484.

199. 487-497.

200. 694-796.

201. 797-800.

202. 848-856.

203. 1016-1039.

204. 1185-1193.

205. 1907-1909.

As is to be expected, the style of the work is modelled on the style of Sanskrit epics with their merits and defects. But unlike his predecessor, Pravarasena, whose epic serves our author to be his model in naming the work, he avoids all extravagant use of puns and word-plays and all purely mechanical devices. The favourite figures of our author are *Utprekṣā*²⁰⁶ and *Upamā*, both of which are used in a very masterly and beautiful manner, each one of which gives us a new stroke of his imagination. Another peculiarity of our author is his accurate knowledge of natural scenes and the behaviour of animals and the life of the simple country folk in which he differs greatly from the practice of Sanskrit poets²⁰⁷. Moreover, the ideas of our author though based on conventional facts, show a new liveliness and beauty. In fact, as a poetic composition, the work deserves our greatest admiration and appreciation than is usually given to it.

The form of the work, however, gives great difficulty in knowing its real nature. Pandit suggested that the work was only a prelude to a more extensive scheme which the author planned to write but which he may or may not have composed²⁰⁸. He points out that if the present work formed the whole of what the writer intended to write, the title becomes a misnomer, because the killing of the Gaudian king is alluded to in a pair of stanzas only and is not enough to give the name to the work. Nor will it explain the expectation aroused by the end of the present fragment where the writer requests the audience to hear the great work which is yet to come. Bühler²⁰⁹, on the whole, agrees with Pandit and adds the argument that the present work is styled in the manuscripts *gāhāvīḍha* which usually signifies the introduction of a work as in the case of the famous *Brhatkathā* of Guṇādhya.

Jacobi²¹⁰ and others, on the other hand, regard the work available, to be all that Vākpati wrote and intended to write. They explain the curious form of the book as due to the epitomisation probably done by the commentator who purged away all the historical matter and kept what was of permanent interest, the description of nature and the mythological incidents, which, according to him, were of greater value than the narration of the story. This will also explain the differences between the various

206. As pointed out by Pandit almost every verse contains the fact and the fancied idea of the poet forming the *Utprekṣā*

207. Cp. particularly vv. 513-658.

208. Introduction pp. xl-xlviii.

209. Vienna Oriental Journal. Vol. I pp. 324-330. Vol. II, pp. 328-340.

210. Gottingische Gelehrte Anzeigen, 1888 pp. 61-75.

manuscripts which differ considerably as regards their arrangement and number of verses.

The present work refers to another of the poet's composition called by him *Madhumathavijaya*²¹¹ or the victory of the enemy of the demon Madhu. Vākpati has himself remarked that this earlier production was the better of the two.

Unfortunately, we do not possess the poem. A single quotation from the work is preserved to us in the *Locana*²¹² of Abhinavagupta where we see Pāñcjanya taunting Kṛṣṇa at his love-lorn condition when he finds the lotus stalks too heavy when he is able to bear the weight of the earth in his boar incarnation. Pischel²¹³ remarks in his grammar that two other verses²¹⁴ are quoted from this work in the *Sarasvatīkaṇṭhābhūṣaṇa*, which, however, is doubtful. By a look at these two verses one can see that they are not quotations from this book but from the *Harivijaya* as is proved by their metre. From the verse of Vākpati given by Abhinava it is evident that the lost epic was also written in the gāthā metre while these two are in the Skandhaka in which *Harivijaya* was composed. There are two more quotations of Vākpati in Mārkaṇḍeya's grammar²¹⁵ which are not found in the *Gauḍuvaho* and may be from his other epic.

We know very little of the personal history of Vākpati himself except that he was a favourite of king Yaśovarman and patronised by him, and possibly a student of the famous dramatist Bhavabhūti. His date, of course, depends on that of his patron whose date in its turn depends upon his conqueror Lalitāditya²¹⁶ of Kaśmīr. From the chronology of *Rājataranginī* which is modified a little by modern scholars it is clear that Lalitāditya's reign extended from A. D. 724 to 760 A. D. His conquest of king Yaśovarman is more accurately determined by Jacobi to fall in the year 733 A. D. Therefore the major portion of the life of king Yaśovarman falls in the first part of the eighth century and in the same period must have been the time of Vākpati's literary activity.

211. Gātha 79.

212. *Dhvanyaloka* p. 152. The verse should be read as follows :—
Lilādādhagguvvūdhasayalamahimaṇḍalassa via jassa /
Kīsa muṇḍāharaṇā tujjha garuṇā aṅgammi /

213. Gram. Prk. Spra. p. 11.

214. Cp. Kavyamala ed. pp. 647, 655.

215. *Prākṛtasarvasva*, pp. 50, 61.

216. *Rājataranginī* IV, 126ff.

THE VIṢAMABĀṆALĪLĀ OF ĀNANDAVARDHANA

Ānandavardhana was a court poet of king Avantivarman and is famous for his work on poetics, the *Dhvanyāloka*, but was also a poet writing in both Sanskrit and Prakrit. The only Prakrit work of his that we know is the *Viṣamabāṇalīlā*²¹⁷ which appears to be a work dealing with the subject of love on the model of *Sattasaī*. Konow²¹⁸ thinks that it must have been an anthology and he is right if we take it to be wholly composed by him alone and not a mere collection. A verse²¹⁹ often quoted appears to be a popular saying. From another reference²²⁰ it appears that the work contained speeches of Cupid and his companions Youth, Spring, Malaya winds and others. A third quotation²²¹ describes the power of good poets which knows no limit and are never repeated as are the sports of good ladies. In one verse²²² Kāma is said to conquer the three worlds and the defeat of the Asuras.

THE RĀVAṆAVIJAYA

There appears to be another Prakrit epic called *Rāvaṇavijaya* or the conquests of Rāvaṇa. It is referred to by Hemacandra in his *Vivēka*²²³ on the *Kāvyaṇuśāsana* where he also quotes a verse from it in the Skandhaka metre stating that the heart of a poet is known by another poet only. From other references there, it is evident that the work began with the praise of good poets, contained the descriptions of town, sunset, the praise of the hero, horses, elephants, and other kindred things which are the usual requirements of a Mahākāvya. The author of the epic is, however, unknown, nor is the work known from any other source.

THE LĪLĀVATĪ

Līlāvati²²⁴ is a short romance in pure Māhārāṣṭrī of an unknown author. From the introductory portion of the work we come to know that he was a son of Bhūgaṇabatta and grand-son of Bahulāditya, but does not give his own name anywhere in the text.

217. The work was also called *Anandakathā* cf. his *Derīśataka* v. 104 Kavyamala Part IX, p. 30.

218. His essay on *Rajasekhara* H. O. S. IV.

219. Tālā jānti guṇā jālā te sahiachī gheppanti / Raikiraṇaṇuggahiāi honti Kamalāi kamālāi // *Dhvanyāloka* p. 62.

220. Ibid p. 152 Cp. Abhinava's comment.

221. Ibid p. 241.

222. *Tam tāṇa sirisahoura* etc.

223. *Kāvyaṇuśāsana* pp. 334-335.

224. Jesalmer Catalogue G. O. S.

It is difficult to know the date of the author. The single Ms. of the work is dated A. D. 1208 and so must be earlier to it. Hemacandra refers in his *Kāvyañusāsana*²²⁵ to a work called *Līlāvatī* but there is nothing to show that the reference is to the present work. The style and the introductory verses of the work, however, make it probable that the writer appears to follow the lead of Vākpati and must have lived later than him.

The romance deals with the love story of king Śātavāhana and Līlāvatī, a princess of the Sīṃhaladvīpa. At the beginning of the work the writer offers salutations to the Brahmanic deities like Hari, Madhumathana, Gaurī, Caṇḍī and others and then proceeds to give the personal information.

The Ms. of the work is preserved in the Jain Bhandar and naturally their orthography is found to affect the work as in the case of *Gauḍavaho*. But there is nothing in the language to show that it is written in the Jain Māhārāṣṭrī. The poetic value of the romance is certainly high and the work deserves to be soon published²²⁶.

MĀHĀRĀṢṬRĪ VERSES IN AJAṆKĀRA WORKS

The early extent of the Māhārāṣṭrī literature can be easily seen from the verses quoted in works on Sanskrit poetics which show abundantly the richness of this literature for many centuries. Even though we do not find Prakrit verses in the early works of Bhāmaha and Daṇḍin they clearly state the existence of a vast Prakrit literature, and the absence of Prakrit verses in their works is due to the scheme which admitted no quotations. The few Prakrit verses of Rudraṭa²²⁸ are his own compositions. But from Ānandavardhana onwards Māhārāṣṭrī verses are found in great number, the *Sarasvatī-kaṇṭhābharaṇa* and the *Kāvyañusāsana* being particularly rich in them. It is also inconceivable that works like the *Sattasaī*, *Rāvaṇavaho* and *Gauḍavaho* should have been left without other imitations in later days, particularly so when they were deemed worthy of imitation by Sanskrit poet like Govardhana²²⁹ and others. Besides the meagre information about the lost Prakrit epics like the *Harivijaya* of Sarvasena and such anthologies as the *Viśambāṇatīla* of Ānandavardhana we meet with names of works and their authors to some extent. Thus Viśvanātha, the famous

225. p. 338.

226. A later work, the *Kaṇṭhābharaṇa* of Rāmapāṇi in 4 cantoes will be soon published by Prof. A. N. Upadhye, M.A.

228. *Kāvyañusāsana* IV, 11-15.

229. His *Aryasaptasatī* is an imitation of *Sattasaī*.

author of the *Sāhityadarpaṇa* who lived in the 14th century, appears to have composed a Prakrit epic called *Kuvalayāśvacarita* of which a single verse is quoted by him. This verse describes a pair of young persons looking at each other. Another older work of the same title and probably of the same theme was known to Hemacandra²³⁰ who refers to it in his *Viveka*. Abhinavagupta²³¹ quotes a Prakrit verse and attributes it to one of his teachers Bhaṭṭendurāja who thus appears to have composed some Prakrit work. Abhinava himself quotes one verse as his own composition in his *Locana*. Dhanika in his *Avaloka* on the *Daśarūpi* quotes many Prakrit verses of which four are his own. One verse points out that while the face, the eyes, and the youth remain the same the beauty of love produces quite a different effect²³². Another verse asks a friend to look at the girl gazing at something and beautiful with affection²³³. At the swelling of the breasts the charming movements of a girl captured all her limbs so that her friends were doubtful of her childhood²³⁴. Another verse points out that the charming talk, sight, and all other activities of a girl excite curiosity in the minds of the co-wives²³⁵. From all these verses, it appears, that Dhanika also composed some Prakrit anthology of erotic contents.

Ānandavardhana quotes some 45 Prakrit verses in his *Dhvanyāloka* out of which 19 are not to be found anywhere else and so remain untraced. Many of them are stray verses and are probably quoted from some anthology or collection of moral sayings. Thus, one verse reports the words of the lover to his beloved to return back from going outside, for the lustre of her face produces obstacles in the way of other ladies going to their lovers²³⁶. Another fine gāthā points out that love-sports lose nothing by repetition²³⁷. A third verse says that the stroke given by the lover on the breasts of the beloved pains the heart of the co-wives²³⁸. In another verse a warrior is described as having arms like the elephants who have broken the golden lotuses of the

230. *Kāvyaṇuśāsana* p. 336.

231. *Locana* p. 223 Read the verse as follows :
 Laṅghiagaṇṇā phalahlāṇo hontu tti vaddhaśīe /
 Haliassa a āśisaṃ pādīvesavaṇi tu nīvvavio //

232. p. 52.

233. p. 52.

234. p. 52.

235. p. 54.

236. *Dhvanyāloka* p. 22.

237. *Ibid* p. 52.

238. p. 52.

wishes and thus have spread fragrance of fame and which are constantly giving out ichor in the form of gifts²³⁹. A fine illustration of the figure Dipaka is found in a verse which points out that value is imparted to night by the rays of the moon, to the pond by the lotuses, to the creeper by flowers, to the autumnal beauty by swans, and to poetry by the appreciative people²⁴⁰. Time is described as either full of poison or nectar or of both or without both for different people²⁴¹.

There are nearly 350 Prakrit verses in the *Sarasvatikanṭhā-bharaṇa*, out of which something like 170 remain untraced. In many cases we lack the exact context out of which they are taken and so they remain somewhat obscure to us. In a verse we find the arrows of Rāma producing horripilations on the body of Rāvaṇa, as if, the poet imagines, they were touched by the hands of Sītā²⁴². Another verse describes the fading away of the natural unsteadiness of the defeated army with their lustre gone, and the sparks in the eyes steady and thus presenting the appearance of lamps drawn in pictures²⁴³. The anger of the proud woman vanishes slowly with the happiness of the new reconciliation and with pain at the recollection of the fault of the lover²⁴⁴. A verse describes how one placed one's eyes on the breasts of the heavenly damsels with anger when he got out of his swoon with the mistaken idea that they are the temples of elephants, evidently describing a fiery hero who has newly awakened in the heaven after his death on the battle-field²⁴⁵. In another verse we find Satyaki, the charioteer of Indra, expressing the intention of his master in the words, 'Oh Lord of the gods, if you value the friendship of Mahamāha hand over the heavenly tree, cast off the feigned ignorance and honour the Yādava people'²⁴⁶. The names and incidents that occur in verses like these go to show that they dealt with some famous episodes in the epics and are probably taken from Kāvya of great extent.

But, besides these, the greater amount of quotations that we meet with here are stray verses which are self-sufficient and require no context for their understanding. Their scope is very

239. p. 97.

240. 109.

241. p. 126.

242. *Sarasvatikanṭhābharaṇa* p. 576.

243. p. 580.

244. p. 651.

245. p. 363.

246. p. 550.

wide and they touch upon diverse topics. But the prevailing tone appears to be the delineation of the sentiment of love of the lower classes of the society in all its aspects. "I die without my wishes unfulfilled" cries a young maiden, 'as there is not even a rumour of my intimacy with the Hālīka youth²⁴⁷.' 'What is the use of knowing whether it is true or false', cries another, 'there is a rumour that the daughter of the Hālīka is in intimacy with the son of the house-holder²⁴⁸.' The breasts of the Hālīka girl are seen by her friends to be like the bunch of the Kadamba flowers full of pollens thrown by the lover and heaving with emotion²⁴⁹. A wily girl wishing to be touched by the youth cries falsely that her hand is burnt by fire²⁵⁰.

There are many verses giving interesting situations. While the traveller drinks water for a long time by letting drop it through his fingers, the girl also makes the jet of water very thin, both with the desire of looking at each other for a long time²⁵¹. The travellers only see the eyes of the woman beautiful in all her limbs, who guards the rice-field and who wards off the birds²⁵². Here and there some advice is given, while descriptions of nature are often to be found. The advent of the rainy season is described as, the clouds rumbling, the Nīpa buds blooming, the peacocks dancing and the moonlight obscured²⁵³. The beauty of a lady is said to put forth sprouts in the foliage-like-hands, as blooming with eyes and giving out fruits with the breasts. A blunt way of expressing love is found in a verse when the lady asks the boy, ill-taught as he is in the use of black letters, to embrace her neck and then she never minds if both go to hell²⁵⁴. Curious and out of the way ideas are also to be met with as when the poet is compared to a thief, with the help of Śleṣa; the poet puts his words with caution, the thief places his foot with care; the poet takes care of the style, the thief often looks at the way; the poet often finds it difficult to get at the desired meaning, the thief finds it hard to get wealth²⁵⁵.

247. p. 615.

248. p. 645.

249. p. 667.

250. p. 669.

251. p. 346.

252. p. 378.

253. p. 383.

254. 471.

255. p. 520.

In the *Kāvyaṇuśāsana*, Hemacandra quotes some 60 verses in the text and some 20 in the commentary. Most of them are quoted in earlier works and only few new ones are found. In one we find a bull addressed to remain silent, it being a suggestion to a paramour to be satisfied²⁵⁶. In another a traveller is advised to go another way as the one he is taking is infested by a woman whose snare is difficult to be broken through²⁵⁷. A verse gives an address of a friend to a lady to walk very carefully, lest she break her slender waist which was produced by the creator with so much exertion²⁵⁸. A woman says to her lover that it is not his body marked with nails nor his eyes rolling with sleep that trouble her heart as much as his lower lip unbitten²⁵⁹. An ironic expression is given in a verse where the poet offers his salutation to the moon who makes the lotuses which are soft, beautiful and of pure fibre and opening at the touch of the rays of the sun, devoid of lustre²⁶⁰. A lady points out that her beauty is fine, the lover's affection is strong and the circle of friends is clever, then no use to paint the feet²⁶¹.

Dhanika quotes 26 Prakrit verses in his *Avaloka* of which 10 remain untraced. In one we find the description of the hero whose mind wavers between two emotions of love and heroism as his wife is crying on one side and the war drums are sounding on the other²⁶². The poet describes the love of a girl born in a noble family by pointing out that all her sports depart with the departing lover and come back when he returns²⁶³.

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256. *Kāvyaṇuśāsana* p. 80. Read
 Āsūiaṃ aṇāṇa jettieṇa tettieṇa bandha dhiin/
 Uvaramasu vasaha eṇhiṇ rakkhijjai gahavañchetan//.
257. p. 31.
258. p. 32. Read :
 Saṇiaṃ vacca kisoari paeṇa jatteṇa ṭhavisu mahivaṭṭhe/
 Bhajjihisi vitthayacchiṇi vihiṇā dukkheṇa ṇimmaviñ//.
259. p. 33 Read line second as follows :
 Jaha nivvaṇāharo sāmalaṅga dūnesi maha hiaṃ//.
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 Kamalaṃ paṭṭhacchāṃ kuṇanta dosāra ṇamo de//.
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262. *Daṣarūpa*. p. 91
263. *Ibid*, p. 43.

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All such stray verses quoted in the Alaṅkāra works produce a strong impression that they are essentially the poetry of the populace with all its frankness and rough good common sense, lack of courtly pomp and delicacy. They lack the usual formal phrases and expressions which are so prominent in the Sanskrit literature and a kind of naturalness imparts them a peculiar charm and simplicity.

A. M. GHATAGE, M.A.

THE POETRY OF TORU DUTT

Cette enfant du Bengale si admirablement et si étrangement douée, Hindoue de race et de tradition, Anglaise d'éducation, Française de coeur ; poète en anglais, prosateur en français ; qui à dix-huit ans faisait connaître à l'Inde les poètes de la France dans le rythme de l'Angleterre et fondait en elle trois âmes et trois traditions, morte à vingt ans, en plein épanouissement du talent et à la veille du génie, présente dans l'histoire littéraire un phénomène sans analogue.¹

This daughter of Bengal was Toru Dutt. She is the foundation stone on which the whole edifice of Indo-Anglian literature is built. Previous to her were the explorers. Derozio started the idea, Ghosh and all the Dutts dug the trenches and sent out saps and feelers here and there. It is not till we come to Toru that we find the first solid achievement. When we have finished with her we shall find that Indo-Anglian poetry has taken a big step forward, which has unmistakably marked its future direction.

Toru Dutt was lucky to be born into the family of the Dutts of Rambagan. She thus secured for herself an ancestry of great intellectual power and no mean culture. Nilmoni Dutt and his descendants are not unknown in the history of Bengal, and judging from their promise and performance it would not be too much to expect just such a fulfilment as was embodied in Toru. Nilmoni's grandson Govin Chunder Dutt married Kshetramoni Mitter. This lady then knew very little English but soon picked it up enough to be able to translate, later, into Bengali a book called "The Blood of Jesus". To these parents Toru was born in 1856.

She died at the young age of twenty-one, having lived the simple life of a girl whose unpretentiousness, whose earnestness and Christian spirit, whose frailty and delicateness, cloaked from the world the fact that she was a rare poetess of much charm and no little genius. True it is that her accomplishment does not rank with the very best in English literature ; and that can be said of Chatterton too ; but they both died too young. And yet both have written enough to show that had they lived longer they would have given a worthy account of themselves.

1. Darmesteter, *Essais de Littérature Anglaise*, p. 269.

Before we examine the small output of Toru Dutt, it may be pointed out that in relation to the time she gave to it that output is not at all small. On the contrary it is astonishing that a little slip of a girl, between the ages of eighteen and twenty-one, should have translated nearly two hundred poems from the French, written two novels, one in English, one in French, and capped that by composing a number of original ballads in English and some miscellaneous verses, not to speak of the several articles and Scenes from Contemporary History contributed to various Journals. Nor is it to be forgotten that both English and French were as far from her mother tongue as the Hebrides is from Cape Town. When we have realized what that means it is time to examine some of her verse.

A SHEAF GLEANED IN FRENCH FIELDS

Her only work which Toru was to see in book form was *A Sheaf Gleaned in French Fields*. The history of this book is interesting from more than one point of view and bears retelling for the modern editions of *Ancient Ballads and Legends of Hindustan*¹ are printed without Sir Edmund Gosse's Introduction in which that history was told for the first time. The book was published by the Saptahik Sambad Press at Bhowanipore in March 1876. A copy of it was sent to *The Examiner* to be reviewed. W. Minto was then Editor of that paper, and one day Sir Edmund Gosse, who was then reviewer, was, in his own words,

upbraiding the whole body of publishers for issuing no books worth reviewing. At that moment the postman brought in a thin and sallow packet with a wonderful Indian postmark on it, and containing a most unattractive orange pamphlet of verse, printed at Bhowanipore, and entitled "A Sheaf Gleaned in French Fields by Toru Dutt." This shabby little book of some two hundred pages, without preface or introduction, seemed especially destined by its particular providence to find its way hastily into the waste-paper basket. I remember that Mr. Minto thrust it into my unwilling hands, and said "There! see whether you can't make something of that!"²

This hopeless volume, with its queer type, had a surprise for Sir Edmund Gosse when, later, he opened it at Aru's rendering of Victor Hugo's Serenade. Being unaware of Aru's collaboration he, of course, thought it was Toru's. He gave the book a very promising review indeed, though he deplored the absence of either Preface or Introduction.³

1. e. g. published by Kalidas & Co. Madras, 1927.

2. *Introductory Memoir to Ancient Ballads and Legends of Hindustan*, p. viii.

3. *The Examiner* (London), August 26, 1876.

The book was dedicated to Madame Govin Chunder Dutt¹ and was sold out very soon. In May 1878, after Toru's death, her father issued a second edition, prefaced by a memoir² written by himself and including additional translations. This was followed in 1880 by a third edition published in England by Kegan Paul & Co. We do not think the book has ever been republished since then.

It would be worth our while to pause a moment to see what Sir Edmund Gosse thought of the translations of this Hindu poetess.

.....her book recalls the French more vividly than any similar volume we are acquainted with; and if modern French literature were entirely lost, it might not be found impossible to reconstruct a great number of poems from this Indian version³

and he concludes the notice by saying

In short, her book, taking for granted that it really is what it seems to profess to be, a genuine Hindu product, is an important landmark in the history of the progress of culture.

Further comments on the importance of Toru Dutt's work are unnecessary. It is obvious to anyone that the publication of the *Sheaf* opened up possibilities of fresh fields to the Indian, possibilities which Toru was the first to explore with any real success.

The *Sheaf* is, at first sight, a haphazard collection of translations from French poets, but to the careful reader it is not without method. Toru has scrupulously avoided every Classicist and has concentrated on the poets of the Romantic and Parnassian period, as we label them now. But earlier writers are not entirely unrepresented. She starts as early as the 16th century with du

1. Mrs. Basu erroneously mentions it as dedicated to Toru's father, *Indian Writers of English Verse*, p. 69.
2. About this Memoir Das is in some slight error. In the footnote on p. 50 of his book, *The Life and Letters of Toru Dutt* (henceforth abbreviated "Das"), he says, about the correspondence between Toru and Mlle. Bader, that it "first appeared in a Memoir of his daughter, written by Mr. Dutt, in the edition of *A Sheaf Gleaned in French Fields*, published by Kegan Paul & Co. in 1880." This memoir actually first appeared in the second, or 'new' as it was then called, edition of the same book published at Bhowanipore. Das (p. 292) is aware of 'a touching biographical notice' in this second edition, but we presume he has not seen it. His information, it would seem, is based upon Gosse whose words too he uses.
3. *The Examiner* (London), August 26, 1876.

Bartas and du Bellay. Nor are others of the 19th century, who cannot be associated with one of the schools, omitted. But all these serve merely as trimmings for the main bulk of Romanticists, headed by Hugo, Soulayr, and de Gramont. The most striking thing about the book is the wealth and variety of material. There are nearly seventy-five poets represented in the collection and many of them are names unknown to the average English reader of French literature. For a clear and almost complete analysis of the collection the reader is referred to Das's book.¹

Toru's method of translation is in many ways the ideal method. It is at once exact and free ; it takes no fundamental liberties with the original yet does not hesitate to give a twist or twang which will make the poem more readable in English. Every effort is made to keep to the spirit of the original by using the same metre as far as possible, though this does not become a fixed rule. Nor ever does her translation become a word for word affair. Words, phrases, whole sentences sometimes, are rejected and substituted by others. Notice, for example, the first stanza of Béranger's " My Vocation ".

The French original goes :

Jeté sur cette boule,
Laid, chétif, et souffrant ;
Etouffé dans la foule,
Faute d'être assez grand ;
Une plainte touchante
De ma bouche sortit ;
Le bon Dieu me dit ; chante,
Chante, pauvre petit !

Toru's translation reads :

A waif on this earth,
Sick, ugly and small,
Contemned from my birth
And rejected by all.
From my lips broke a cry,
Such as anguish may wring,
Sing,—said God in reply,
Chant, poor little thing.²

The third and fourth lines have undergone a complete change. " Une plainte touchante " becomes " such as anguish may wring ".

1. pp. 297-300.

2. *Sheaf*, p. 17. All page references to the *Sheaf* are to the third edition of 1880.

But her weakness is obvious too—the substitution of “sing..... chant” for “chante, chante”. “Sing..... sing” would have been more emphatic and English, but she was frightened into a compromise.

The sensitiveness of her ear to English is seen in lines like :

Methinks Remorse

Hath such a cry, and such a force—

Wail mothers thus for children gone.¹

The whole effect of the last line is in the simple inversion so adroitly made.

But perhaps the most effective way of showing both the vigour and beauty of Toru's work is to compare her translation with somebody else's. “The Rose and the Tomb”, a poem by Hugo, is translated both by Toru and a Mr. Hodgson. This is the original:—

La tombe dit à la rose :
—Des pleurs dont l'aube t'arose
Que fais tu, fleur des amours ?
La rose dit à la tombe :
—Que fais tu de ce qui tombe
Dans ton gouffre ouvert toujours ?
La rose dit:—Tombeau sombre
De ces pleurs je fais dans l'ombre
Un parfum d'ambre et de miel.
La tombe dit:—Fleur plaintive,
De chaque âme qui m'arrive,¹
Je fais un ange du ciel !

Toru renders it thus:—

The tomb said to the rose,—
Of the tears the night strows,
What makest thou, O flower of the dawning ?
The rose said to the tomb,—
Of what falls in thy womb,
What makest thou, O gulf ever yawning ?
The rose whispered—O tomb !
From those tears shed in gloom,
Is the scent famed in song and in story.
The tomb said—O my pet !
Of each soul that I get
I create a winged angel of glory.²

1. From Hugo's “Lines”, *Sheaf*, p. 76.

2. *Sheaf*, p. 84.

It will be noticed that the metre is as near to the original as possible without sacrificing any clarity or sense in English. Let us see what Mr. Hodgson does :—

With those bright tears of limpid dew,
Which on thy leaves each morn I view,
What dost thou, flower of beauty, do ?
One day demands a tomb.

Four lines for three, twenty-seven words for nineteen of Hugo's and twenty of Toru's ! and how pompous the whole ! and why all those adjectives—'bright' and 'limpid' ? Why 'each morn I view' ? Why 'one day' ? Why 'demand' ?—These whys will never be answered. Then, of course, instead of the beautiful device of Hugo's, of question following question, there comes staid old English order with answer following question ! (It is said the *French* language is logical !)

The rose replies : In stilly night,
With those sweet tears of pearly white
Are fed my flowers of rich delight,
That all around perfume !

'Stilly', 'sweet', 'pearly', 'rich'—more adjectives ! more padding ! By contrast, Toru's simple rendering seems very effective indeed, though both have missed the 'ambre' and the 'miel' of Hugo. It is useless, and perhaps not very fair, to quote any more of Hodgson's translation. What we have already cited is sufficient to show the salient points of Toru's work. Her strength lies in her entering into the spirit of the original in a fashion which few translators do. There seems to be something common between them, some strong tie which binds the Romanticists of French literature to the heart of this Hindu girl. This it is that lends fire to her pen. Sometimes she writes with a force that seems to have come from within her. For example, 'To those Who Sleep' from *Les Châtiments*—it is Hugo once again, but that cannot be helped.

Lo ! He lifts up His hand,
And the tigers fly howling through deserts of sand,
And the sea-serpents crawl,
Obedient and meek ! He breathes on idols of gold
In their temples of marble, gigantic and old,
And like Dagon they fall !
You are not armed ? It matters not,
Tear out the hinges of the door !
A hammer has deliverance wrought ;
David had pebbles from the shore.

Shout for the Cause—the flag advance !
 Become once more the mighty France !¹

Very often in the *Sheaf*, if there is nothing else to distinguish a translation, the metre at least is smooth and suggestive of no labour or hard toil in its making. Such for instance is Bérat's "My Normandy"² or Peyrat's "Roland"³, the latter in a form not easy to sustain evenly for a hundred lines.

Toru tried her hand at blank verse too, but not very successfully. In a note to a piece by Louis Bouilhet she says :—

Although a Frenchman would faint away at the idea of blank verse, which is not allowed in French poetry, we have not hesitated to render this piece in that form, as well as others.⁴

Her lines are all end-stopped, and she is never really happy in blank verse, though a few lines in "The Death of the Wolf"⁵ and some in the *Ancient Ballads* lead us to believe that with more practice she would have been just as much at home in that form as in so many others, notably the sonnet.

But before coming to the sonnet there is one fact which must not go without mention. Reading so much French poetry Toru could not help coming across some of that delightful lighter verse which for its subtlety, elegance and wit is hard to rival outside French literature. Toru has fortunately given us one or two examples of that type and shows how well she could handle the *raffinement* of the French without destroying its polish or elegance. This is the conclusion of a sonnet by Scarron :—

Proud monuments all of every age and clime,
 Ye are demolished or are crumbling down
 Under the look of the destroyer, Time.
 Should I then murmur that beneath his frown
 After two years, well measured, chime by chime,
 Out at the elbows is my dressing gown ?⁶

Toru seems to have had a great liking for the sonnet form, judging from the fact that there are nearly forty sonnets amongst her translations. Of her partiality to this form

1. *Sheaf*, p. 88.
2. *Ibid.* p. 73.
3. *Ibid.* p. 311.
4. *Ibid.* p. 369.
5. *Ibid.* p. 59.
6. *Ibid.* p. 5.

her biographer Das is aware¹, and yet one is surprised to find him say, about fifty pages later when he is discussing the *Ancient Ballads* :—

The next two poems, 'Baugmaree' and 'The Lotus', are interesting, apart from their matter, as being the only poems (that we know of) written by Toru in sonnet form. Their success makes us regret that she did not use the form more frequently.²

If Das is talking of form and not matter then there are many sonnets in the *Sheaf*—by Soulayr, de Nerval, Baudelaire, Sainte-Beuve, Deschamps, Leconte de Lisle, de Gramont and one of the earliest practitioners of that form, Du Bellay. And even if Das means original sonnets there is at least one more which seems to have escaped his notice—the one written to her father at the conclusion of the *Sheaf*. In a letter to Miss Martin, Toru says of that sonnet "it is not from the French, but it is original".³ In fact it can be easily seen that Toru used the French translation work as a good practising ground. It was there she learnt all her use of forms and rhymes and, having graduated from that school, tried her hand later at original verse. It will also be noticed that most of de Gramont's sonnets have been first printed in the new edition of the *Sheaf* and it may be presumed that her "Baugmaree" and "The Lotus", which are such good examples of that form, belong to the same later period just preceding her death. Here is a bit out of Heine's sonnet to his mother.

Am I o'erwhelmed because thy powerful soul
Penetrating all earthly things is lost
In God's own bosom, its predestined goal !
Or is it rather that my mind is crost
By memories sad and wounds I often gave
A heart so tender, loving, patient, brave ?⁴

On the whole the *Sheaf* is a very remarkable performance by a girl barely out of her teens. It was well praised by André Theuriet in the *Revue des Deux Mondes*, and Sir Edmund Gosse spoke highly of it. But it is curiously uneven in merit. There are poems which read like bad prose translations, their closeness to the original being their sole merit, but there are others which are distinct products of genius. In this curious medley of "strength and weakness", as Sir Edmund Gosse calls

1. Das, p. 298.

2. Ibid. p. 340.

3. Ibid. p. 112.

4. *Sheaf*, p. 67.

it, the thing that strikes us as perhaps most remarkable is not her command over two foreign languages or her poetic gift. What leave us astounded are the notes she has appended to her translations. In them we see as clear as daylight that had Toru lived to a greater age she would have bid fair to rival that very Sainte-Beuve whom she so praises for his critical qualities. The notes must have taken Sir Edmund Gosse himself by surprise for he writes :—

Occasionally she showed a profundity of research that would have done no discredit to Mr. Saintsbury or "Le doux Asselineau". She was ready to pronounce an opinion on Napoléon le Pyrénéen or to detect a plagiarism in Baudelaire.¹

She has an eye that perceives all and a memory that remembers all. She makes comparisons of old and new, of this country and that, of East and West, with a boldness which is astonishing. She picks out holes with a fearlessness which is enviable. She gives praise with a generousness worth copying. Open the notes at any page and read at random. The sheer extent of her knowledge is bound to leave us gaping. Here is a note to a poem by Emile Deschamps. We plunge into the middle of it.

Antoni Deschamps, brother of Emile Deschamps, has not much resemblance to him as a poet. Antoni is stiff, cold, uniform austere, sometimes sublime, whereas Emile is varied, supple changing and graceful. Antoni has written little or no prose, Emile has written a great deal of prose as well as verse. Antoni has devoted himself to the poetry of Italy, Emile has fluttered about from the poetry of Germany to the poetry of England, of Italy and Spain. Antoni's translation of Dante in which he has wished to give according to his own expressions 'an idea of the tone and manner of Dante,' is a noble work a model for all who undertake the work of translation. He abstains from all notes and commentaries, and endeavours to produce with a religious fidelity 'the colour and especially the accent' of the poetry of the great master; and his success is wonderful. His other works are: 'Etudes sur l'Italie', in which the influence of his attentive study of Dante is always apparent, and 'Elegies', in which his own private life and its sorrows are laid bare with a power that fascinates, and 'Resignation' (his last work, we believe), a sort of sequel to the 'Elegies', not unworthy of the fame he had previously won.²

That is not all. Then follow some remarks upon his never having fallen in love, with sixteen lines of his verse translated into English verse.

O Shades of Plato and Aristotle, Cicero and Horace ! Shades of Sidney, Puttenham, Boileau, Johnson and Coleridge ! Shades

1. Introductory Memoir to *Ancient Ballads*, p. xvi.

2. *Sheaf*, p. 343

of Sainte-Beuve, Taine, Arnold, Saintsbury, Gosse ! how you must have trembled for the safety of your laurels ! Rest in peace—now they are safe ! Death intervened on your behalf and took away the little Hindu girl before she had come of age—a fairer laurel herself than any you ever gathered !

In a beautiful sonnet entitled "A Mon Pere", with which she concludes her *Sheaf*, Toru compares the poems, she has selected and translated, to hillside flowers which lose their colour on being plucked. She admits it was pleasant to wander through the valley and gather her spoil,

But better than myself no man can know
How tarnished have become their tender hues
E'en in the gathering and how dimmed their glow !
Wouldst thou again new life in them infuse,
Thou who hast seen them where they brightly blow ?
Ask Memory. She shall help my stammering Muse.¹

That is Toru's genius—to realize her own weakness and the difficulty of her task. Are we wrong in suggesting that she would have turned out to be a greater critic than poet ?

But we have not yet done with the *Sheaf*. One little bit of it is usually passed over as insignificant. Even people who have heard of Toru Dutt are unaware of its existence. The bit amounts to only about eight poems of the *Sheaf* but they deserve mention, nevertheless, for had it not been for one of those very eight poems Toru herself would have very probably been in the limbo of forgotten Anglo-Indian curiosities. I am referring to the share of Toru's sister, Aru, in the translations.² It is not generally known that the poem which was the cause of Sir Edmund Gosse's "surprise and almost rapture" when he first opened the *Sheaf* was not by Toru but by Aru. Besides Victor Hugo's "Morning Serenade" Aru has translated half a dozen other poems by different writers and throughout she shows a command over the language and verse forms which rivals that of her sister. Whether it is in Chénier's almost ballad-like "The Young Captive"³ or Etienne's more delicate "Romance of Uma"⁴ her flow is always smooth and her rhythm ever sure, and in poems like the latter she reaches a lyricism which one does not find so easily in Toru.

1. *Sheaf*, p. 335.

2. There is also one poem marked with the initial "G" a fact which has escaped the observation of Das. We presume it is by the father, Govin Chunder. It is Xavier de Maistre's "The Butterfly." *Sheaf*, p. 10.

3. *Sheaf*, p. 8.

4. *Ibid.* p. 16.

O echo whose repose I mar
 With my regrets and mournful cries,
 He comes—I hear his voice afar,
 Or is it thine that thus replies ?
 Peace ! hark, he calls ! — in vain, in vain,
 The loved and lost comes not again.

If, however, there is one poem which stands head and shoulders above all the others in the entire *Sheaf*, it is Hugo's "Morning Serenade". Aru's rendering of it reaches a highwater mark which Toru never reached. Nothing would be more appropriate for us than to take leave of the *Sheaf* by citing it in full.¹

Still barred thy doors ! — the far east glows,
 The morning wind blows fresh and free,
 Should not the hour that wakes the rose
 Awaken also thee ?
 All look for thee, Love, Light and Song ;
 Light, in the sky deep red above,
 Song, in the lark of pinion strong,
 And in my heart, true Love.
 Apart we miss our nature's goal,
 Why strive to cheat our destinies ?
 Was not my love made for thy soul ?
 Thy beauty for mine eyes ?
 No longer sleep,
 Oh, listen now !
 I wait and weep,
 But where art thou ?²

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1. For those who may be interested in comparing the translation with the original we give here the first stanza of Hugo's "Autre Chanson" in French.

L'aube naît et ta porte est close !
 Ma belle, pourquoi sommeiller ?
 A l'heure où s'éveille la rose
 Ne vas-tu pas te réveiller ?
 Oh ma charmante,
 Ecoute ici
 L'amant qui chante
 Et pleure aussi !

2. *Sheaf*, p. 77. We are continuing to take the liberty which Sir Edmund Gosse first took of publishing the refrain only once, at the end of the three stanzas. It reads better thus,

ANCIENT BALLADS AND LEGENDS OF HINDUSTAN

The second volume of Toru's poetry was published posthumously in 1882 with an Introduction by Sir Edmund Gosse. But between her death in 1877 and the publication of the *Ancient Ballads* several of her creations saw the light. Translations of eight of le Comte de Gramont's Sonnets were printed in the Calcutta Review, No. CXXX of 1877. A fragment of a romance in English called *Bianca, or The Young Spanish Maiden* was serially published in *The Bengal Magazine*, January-April 1878. In May 1878 a second edition, already mentioned, of the *Sheaf*, was published, containing all the newly discovered translations. In 1879 Mlle. Clarisse Bader edited and published in Paris Toru's French novel *Le Journal de Mlle. d'Arvers*. This is not the place to speak of her prose works, but it might interest the reader to know that the French romance was highly praised by several critics both English and French. And in 1880 came out the third and last edition of her *Sheaf*. Two more years had to elapse before the publication of the *Ancient Ballads*. And yet, as Sir Edmund Gosse wrote in the Introductory Memoir,

We believe that the original English poems, which we present to the public for the first time to-day, will be ultimately found to constitute Toru's chief legacy to posterity.¹

This volume, called in full *Ancient Ballads and Legends of Hindustan*, was in reality a collection of the poetic remains of Toru Dutt, for besides containing the series of Ballads which Toru herself had planned there was in it a section of miscellaneous poems which, according to many critics, are the best works of Toru. The most striking thing about the *Ancient Ballads* is that Toru is growing back into her own nation after having been alienated from it for a long while by two foreign literatures. One year's work at Sanskrit and the inspiration of her earliest recollection of stories told by her mother bring her back to the very heart of India. Here all artificiality is banned, all superficiality has disappeared, only Toru remains, with roots which have just begun growing into her own land. To ask how deep these roots would have grown is a matter of vain and melancholy speculation; it is enough to know that they are healthy and strong roots.

It seems that Toru had planned a series of nine ballads but when they were discovered by her father after her death two were missing, or perhaps not written. He filled up the gap with "The Legend of Dhruva" and "The Royal Ascetic and the Hind" two stories which she had translated from the *Vishnu Purana*, and

1. *Ancient Ballads*, p. xxii.

which had already been printed in *The Bengal Magazine*, October 1876, and *The Calcutta Review*, January 1877, respectively. These two were her first experiments and are both written in blank verse. There is nothing notable in either translation or story, and Toru, it seems, was quick to discover their faults for thereafter she abandons blank verse entirely for purposes of narration. To us

their chief interest must ever lie in the fact that they mark the beginning of a new phase in the development of Toru's genius, namely, her desire to give expression to her intense love of her own land and its traditions.¹

Of the other ballads, in the absence of dates, we may be permitted to have a shrewd suspicion that "Savitri", "Lakshman" and "Jogadhya Uma" are the later ones in comparison with "Buttoo," "Sindhu," "Prehlad" or "Sita", for these last four show in no way the accomplishment of the first three. They very obviously lack the strong narrative power of the others. Their stories do not go with the swing with which we have become familiar in the first three tales. The characteristic common to most of these ballads is the octosyllabic metre borrowed from the English ballad form. Toru found that it lent itself very easily to her simple style, so she used it without hesitation. Besides the blank verse experiment she tried rhymed pentameter, in "Sita", and a variation on the octosyllabic measure, in "Sindhu".

What appeals to us most about these ballads, and especially about "Savitri", "Jogadhya Uma", "Lakshman" and perhaps "Prehlad", is the manner in which nothing is allowed to interrupt the action of the poems. In "Savitri", for example, though the action of the story is slow in starting the later lines go with a breathless swing, and before you know where you are you are at the end of a thousand lines of rhymed verse. But neither rhyme nor poetry is allowed to come in the way of the story. It is primarily a ballad and there are no out of the way phrases, similes or metaphors to catch your attention and make it linger in dalliance with beautiful forms or words. The poet hardly ever emerges from the narrator and the story is left to tell itself in stark nakedness. Nor is it only her directness of narration that appeals to us so much. Together with the complete absence of deviation or ornament there is a ruthless frankness and a charming naiveness which expresses itself in all manner of ways—sometimes

1. Das p. 331.

rather like a little girl's story-telling, as for example in the ending of "Sindhu"—

What is the sequel of the tale ?
 How died the king ?—Oh man,
 A prophet's words can never fail—
 Go, read the Ramayan.¹

or sometimes with a bewildering simplicity springing from the depth of her heart, as for example in "Yogadhyā Uma":—

Absurd may be the tale I tell,
 Ill-suited to the marching times,
 I loved the lips from which it fell,
 So let it stand among my rhymes,²

Just such a conclusion might Chaucer's clerk have given to his tale of Gentle Griselda, but whereas Chaucer abounds in such remarks Toru Dutt relies upon their rarity in producing the desired effect. It seems a far cry from Chaucer to Toru Dutt but we cannot help noticing other similarities too. As in Chaucer so in Toru characterization plays a not unimportant part. In the ballad of that name Savitri is all that matters and she is very well depicted. Every method is used to emphasize her gentleness, her charm and her persistence to win by love what she desires most. Her wisdom and understanding of life and death help her to preserve a calm countenance when Death has carried away her beloved husband. She says:—

Man call thee Yama—conqueror,
 Because it is against their will
 They follow thee,—and they abhor
 The truth which thou wouldst aye instil.
 If they thy nature knew aright,
 O god, all other gods above !
 And that thou conquerest in the fight
 By patience, kindness, mercy, love,
 And not by devastating wrath,
 They would not shrink in childish fright
 To see thy shadow on their path,
 But hail thee as sick souls the light.³

But even more vividly than Savitri has Toru painted for us Sita in the second ballad "Lakshman". It is just a little fragment from the epic of Rama and Sita, yet this little

1. *Ancient Ballads*, p. 106.

2. *Ibid.* p. 64.

3. *Ibid.* p. 34.

fragment shows what a consummate mastery of the ballad form Toru had acquired. In twenty-two stanzas we seem to feel we have known Sita all her life. Toru excels mainly in depicting women. Lakshman and Sita are alone in the forest while Rama has gone hunting, having left instructions that Lakshman should not leave Sita alone. Suddenly they hear a cry as of Rama's and Sita asks Lakshman to go to his brother's help. Her wail, her fear, her inward thoughts and suspicions, the very working of her mind, have all been depicted with amazing skill. She begs Lakshman to go, she persuades him, she dares him to go,

Oh shame ! And canst thou make my weal
A plea for lingering ! Now I know
What thou art Lakshman ! And I feel
Far better were an open foe.¹

until the weight of her logic and the force of her great love compel him to yield—

Hear me, O Queen, ere I depart,
No longer can I bear thy words,
They lacerate my inmost heart
And torture me, like poisoned swords.²

It has been pointed out³ that, in this series of ballads, Hindu conceptions and Hindu ideals of Duty have been delineated by Toru Dutt with considerable power. While Savitri is the ideal wife, Lakshman is the ideal brother, and Sindhu is the ideal son. When Sindhu is dying his thoughts are still of his duty to his parents. His voice is heard,

“ Oh God ! ” it said—“ I die,—I die,
Who'll carry home the pail ? ”⁴

In India a Guru, or master, is worshipped almost like a parent, so in Buttoo we have the ideal pupil. Buttoo was refused coaching by Dronachariya, who was a great master of the art of archery, because Dronachariya had promised Arjuna that he would teach him alone the greatest secret of the art — viz., aiming by ear — so that there would not be Arjuna's equal in the land. Buttoo set up a statue of the master in secret and worshipped it and after years of hard practice acquired the innermost secret of archery. When Dronachariya and Arjuna discover that there is a third person who

1. *Ancient Ballads*, p. 49.

2. *Ibid.* p. 51

3. Natesan, *Toru Dutt: A Sketch of her Life and an Appreciation of her Work*, p. 19.

4. *Ancient Ballads*, p. 95.

shares the secret with them, Buttoo still so reveres the master who was his inspiration that he is prepared to do anything for him, Under Arjuna's pressure Dronachariya asks Buttoo to give up his right thumb. That would mean the end of archery — all his years of patient labour in vain ! But does Buttoo hesitate ?

Glanced the sharp knife one moment high,
The severed thumb was on the sod,
There was no tear in Buttoo's eye
He left the matter with his God.¹

All this is definitely Hindu in conception, unmistakably of Toru's race and country. There are references also to the Doctrine of Karma and belief in omens, and there is not an infrequent statement of the fatalistic philosophy so popular in India.

It is my destiny,
O fear not thou, but pity one
Whose fate is thus to die.²

Both "The Legend of Dhruva" and "Sindhu" are entirely based on the doctrine of Karma. But that does not for a moment mean that Toru was in complete accord with all the religious and philosophical teaching of her nation. There is at least one passage that shows unmistakably that she did not agree with that part of the religious teaching which advocated asceticism. The moral she draws from the story of "The Royal Ascetic and the Hind" is by no means couched in vague terms.

Not in seclusion, not apart from all,
Not in a place elected for its peace,
But in the heat and bustle of the world,
'Mid sorrow, sickness, suffering and sin,
Must he still labour with a loving soul
Who strives to enter through the narrow gate.³

It is not possible, nor perhaps desirable, to tell here the stories of most of these ballads. As stories they are not much, but their charm lies in Toru's telling. "Yogadhya Uma" is perhaps most representative of Toru's best qualities. It has all that narrative wants and all that poetry and romance want, and we read on bewitched until almost with a jerk we come to the end

They bowed before the mystic Power,
And as they home returned in thought,

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1. *Ancient Ballads*, p. 88.
 2. *Ibid*, p. 97.
 3. *Ibid*, p. 70.

Each took from thence a lotus flower
In memory of the day and spot.¹

Uma is Parvati, the wife of Shiva, and "Yogadhya" means sitting in meditation. The picture of the dreamy-eyed goddess on the water bank is almost unforgettable. The whole ballad, in fact, has that intensely dreamy atmosphere so symbolic of India at noon.

The birds were silent in the wood ;
The lotus flowers exhaled a smell
Faint over all the solitude ;
A heron as a sentinel
Stood by the bank. They called,—in vain.
No answer came from hill or fell,
The landscape lay in slumber's chain
E'en Echo slept within her cell.
Broad sunshine, yet a hush profound !²

Only those who have been to India can know how true the description is. Some radiant morning, if you happen to be there, in the midst of the tropical foliage, you should not be surprised if you behold some goddess near a pellucid lake for it is a land fit for gods and goddesses.

In a collection of ballads by a girl it would not be difficult to find faults if we want to, but in Toru Dutt there is so much that is good that we are inclined to close our eyes to them. It certainly is beside the point to show that she is still so immersed in things Western that she calls a temple a 'manse' or that she uses Spenserian archaisms like "Satyavan was'he hight".³ These are temporary phases through which she had to pass and we are already given signs of their transitoriness in one or two of the Miscellaneous poems. It is true too that her ear betrays her occasionally and she allows herself a wrong accent or a bad rhyme. But what English poet is there entirely free from lapses ! The most serious accusation, however, is that which comes from the eminent orientalist, R. W. Frazer. He says :

The poems.....can never take an abiding place in the history of English or Indian Literature. The old ballads and legends have lost all their plaintive cadence, all the natural charm they bore when wrapped round with the full-sounding music of the Sanskrit, or in what lay ready to the hands of the poetess, her own classical Bengali.⁴

1. *Ancient Ballads*, p. 63.

2. *Ibid.* p. 62.

3. *Ibid.* p. 5.

4. *A Literary History of India*, p. 432.

This was written only sixteen years after the publication of the *Ancient Ballads*. To-day, more than fifty years have passed since that event and we are glad to say R. W. Frazer is proved wrong for Toru's place is in both literatures. In his praise for Sanskrit Frazer is biased. He does not realize that, in a sense, Sanskrit is as much a dead language in India to-day as Greek or Latin in Europe. If Toru had retold the tales in Sanskrit she could not have chosen a surer or quicker means to oblivion. Another equally eminent orientalist, James Darmesteter, thought differently from Frazer :

Son histoire de Savitri, cette Alceste de l'Inde plus heureuse que sa soeur de Grèce, s'ouvre avec une grâce que n'a point le texte original, si souvent déparé par le pédantisme et la lourdeur que la littérature classique de l'Inde a jetés sur les plus beaux motifs de la tradition populaire.¹

So much for the plaintive cadence and full-sounding music of the Sanskrit ! In Bengali it might have been different, but still it would have been restricted to one province of India only. Thanks to English, to-day the whole of India reads her and appreciates her increasingly every day.

But we have lingered over the Ballads very long when more tempting fare awaits us. The section of Miscellaneous Poems at the end of the volume comprises some seven of Toru's original lyrics. They survey nearly the whole of her period of production for the earliest was written during her stay in England, 1870-1873, when she was merely a child of fifteen perhaps, and the latest a few months before her death. They are very uneven in merit, the earlier ones being technically bad too. "Near Hastings" and "France-1870" are both sincere and deeply felt and the latter has a vigour of expression which makes us easily overlook the ruggedness of its metre.

Not dead,—oh no,—she cannot die !

Only a swoon, from loss of blood !

Levite England passes her by,

Help, Samaritan ! None is nigh,

Who shall stanch me this sanguine flood ?²

There are two sonnets which, apart from any intrinsic poetic beauty of their own, are very good compositions in that form of verse. "The Lotus" is a quaint story of the birth of that flower, while "Baugmaree" has made immortal for us the place where

1. *Essais de Littérature Anglaise*, p. 282.

2. *Ancient Ballads*, p. 129.

Toru spent the greater portion of her life. It is an exquisite piece of landscape painting done with a poet's brush :—

And o'er the quiet pools the seemuls lean,
 Red,—red, and startling like a trumpet's sound.
 But nothing can be lovelier than the ranges
 Of bamboos to the eastward, when the morn
 Looks through their gaps, and the white lotus changes
 Into a cup of silver. One might swoon
 Drunken with beauty then, or gaze and gaze
 On a primeval Eden, in amaze.¹

Last comes "Our Casurina Tree". Nothing could be better than to quote what Mr. E. J. Thompson says of it in the Supplementary Review at the end of Das's book.

One of the Stanzas drops into conventionality, and uses adjectives and thought that are secondhand and otiose. But the poem's strength is independent of this; and its blending of pathos and dignity of spirit, its stretching out of ghostly arms to those other haunted trees of Wordsworth's in "Borrowdale", the conclusion—so recalling the last work of another poet, far inferior in genius but dying equally young, Kirk White, in the touching close of his *Christiad*—all this forms a whole of remarkable strength and beauty, and should achieve her hope of placing the tree of her childhood's memories among those immortalized by 'mighty poets in their misery dead'.²

That is all we have of Toru's work. Yet it is enough for us to form a reasonable estimate of her poetic qualities. Mr. H. A. L. Fisher has no hesitation in enrolling "this child of the green valley of the Ganges.....in the great fellowship of English poets",³ and Sir Edmund Gosse is quite sure that a page in the history of English literature will be "dedicated to this fragile exotic blossom of song".⁴ The one quality that marks Toru Dutt out is her eager spontaneity and childlike simplicity of utterance. This is the keynote to her whole life as will be clear to any reader of her letters. On her death her father writes to her friend Miss Martin.

Your letter to Toru's address was delivered to me this morning. Toru has passed from the earth. She left us last night at 8 p.m. and her end was perfect peace. She loved you very much. I have no doubt, loves you still. I shall send you hereafter one or two trifles to keep as reminiscences, but do not

1. *Ancient Ballads*. p. 135.

2. Das, p. 343.

3. Foreword to Das's book, p. vii.

4. Introductory Memoir to *Ancient Ballads*, p. xxvii.

find myself able to write just at present. The Lord bless you for all you have been to my beloved child.¹

How simple, and how brief ! There is no doubt that Toru inherited her simplicity and Christian piety from her father. But to these she adds a naiveness and freshness, for which alone if for nothing else, her work is worth preserving.

Her place in Indo-Anglian literature could not be exaggerated even if we tried. She is distinctly the first Indian to handle English verse with freedom and originality, and this surprised many an English reader of her day. When the *Sheaf* was published it was suggested that the author was an Englishman hiding under the pseudonym of "Toru Dutt". But her achievement lies not merely in her linguistic acquisition or technical attainment of verse forms. There was in her a true inborn poetic spirit which would have found an outlet in one language or another sooner or later. That it was English she chose was due to circumstances laying it ready to her hand. That it was sooner and not later we are to thank our stars. Toru has gone but she has opened wide the gates of English poetry for her compatriots to follow. She had time only for a fleeting glimpse of the fresh fields and pastures new ; just one or two sniffs of the strange rich air ; she quickly gathered a posy of the flowers near at hand not knowing that they would have to be strewn in a moment on her tombstone near the gates.

Mais elle étoit du monde, où les plus belles choses

Ont le pire destin ;

Et, rose, elle a vécu ce que vivent les roses,

L'espace d'un matin.²

DR. B. K. TALOOKDAR

1. Quoted in Das, p. 309.

2. Malherbe, quoted on fly-leaf of Das.

The above is a chapter adapted from a thesis submitted to the University of Dublin.

ON MEDIUMS

To start with, I must be fair to my reader. If the title of this essay has raised in him any high expectations of some sensational disclosures or thrilling discourses about those mysterious beings who form the centre and chief curiosity of spiritual seances, he will be disappointed. For, frankly I disclaim all intention and competence to enter into that enchanting, twilight region of psychic phenomena. My theme is a more modest one, and if it has less of the twilight about it, it is, I think, still equally enchanting. The mediums in which I am interested and whose meaning and significance I propose to investigate, are the mediums of the various fine arts. To be more precise, however, it is not the mediums in their specific characters, that in which they differ from one another and the qualities in virtue of which they are what they are severally, but their general character as medium with which I intend to deal. In other words, my attempt in this essay will be directed towards finding out what people understand and what they should understand when they talk about the medium of any art.

It is obvious from this that I feel that the concept of 'medium' is rather a hazy one in the minds of those who employ it in their criticism of art in our day. In earlier times, when artists were more intent on producing works of art than on determining critically what exactly they were doing when engaged in their artistic pursuits and why they were doing it, they did not worry about analysing the mental processes involved in artistic creation and accessible to them at first hand, and determining which of those were vital and primarily relevant to their work as art and which were not. Lacking this critical attitude, they were inevitably led to echo what others who were supposed to 'judge' their works said about these mental processes and about their mental equipment as artists. Now, these 'judges' stressed those points in which the artist seemed to touch them, and failed to grasp or misconceived that essential in which he differed from them and by virtue of which he alone became an artist from among a crowd of otherwise similarly or even better endowed men and women. It was natural then, that the medium of art, a consideration of which takes us, to quote Dr Bosanquet, "to the precise root and source of the whole principle of aesthetic expressiveness" and would reveal to us "the

secret of beauty", received scant justice from the artists in their utterances : that is, I mean, they failed to recognise, always and explicitly, the true significance of medium, although this did not prevent them, so long as they obeyed their innate artistic inspiration, from realising it in their work instinctively and as it were quite unconsciously. The result is that the traditional efforts to clarify a concept, which become such a great help in further elucidating it, are sadly lacking in this case. Even when the importance of medium was realised, as by Lessing in his *Laocoon*, the whole discussion appears to be vitiated by an ambiguity in the term 'beauty' and by a failure to appreciate that specific nature which distinguishes fine arts from moral philosophy, science or any other pursuit of the human spirit, and which is the sole justification of their separate existence. Dr. Bosanquet also does not try to analyse the concept of medium in his *Three Lectures on Aesthetic*; confuses consequently, so I am afraid, medium with material—about which more presently—even speaks of "the wall of a cave, or a plate of gold, or a scrap of paper" as medium; and misconceives the nature of poetic medium.

Of very recent years, however, artists are becoming more self-conscious and, therefore, more fruitfully self-critical. On the other side, art critics and aesthetic philosophers are abandoning their judicial, a priori and humanistic attitude and are submitting themselves to a more truly aesthetic and, therefore, a more enlarging, a more helpful experience. The concept of medium is at last assuming an importance commensurate with its necessity in artistic creation. A year or so ago, a reviewer, I think in *The Times Literary Supplement*, defined art as an organisation of form in terms of a medium. I do not think there could have been a truer definition than this one, if only we made sure that we understood the term medium rightly. I believe that a thorough analysis of this term is the first requisite of a valid aesthetic and that an understanding of its precise meaning and value will solve many of the problems which are perplexing our art critics and on which an apparently endless battle is now-a-days raging; such, for example, as those about 'representation' and 'non-representation', about 'truth', about 'imitation of Nature', about the nature of poetry as a fine art, and several others.

What then is a medium? I shall enumerate below the several meanings of the word given by the New Oxford English Dictionary.

1. (a) Middle quality, degree or condition.
- (b) Moderation.
- (c) Middle course, compromise.
- (d) Something intermediate in position.

2. Middle term of syllogism ; hence, a ground of proof.
3. Mean, average.
4. Any intervening substance through which a force acts on objects at a distance or through which impressions are conveyed to the senses: e.g. air or ether.

“The air which is the medium of music and of all sounds.....”.

Hence, pervading or enveloping substance ; the element in which an organism lives ; one's environment.

“You cannot thus abstract any man from the social medium by which he is surrounded.” Grote.

5. An intermediate agency, means, instrument or channel : also, intermediation, instrumentality, as in ‘by or through the medium of’.

—Medium of exchange or circulation.

“The proposition is peace. Not peace through the medium of war ;.....” Burke.

6. Painting :—Any liquid vehicle (oil or water) with which pigments are mixed for use.
 - (b) Any of the varieties of painting as determined by the nature of the vehicle employed: e.g. oilpainting, water colour, tempera, fresco etc.

Photography :—Varnish used as a vehicle in retouching.

7. Theatrical :—A screen fixed in front of a gas-jet in order to throw a coloured light upon the stage,

A glance at these significations will at once reveal to the reader the fact that even in the sphere of fine arts the word medium does not always denote the same type of concept. You might say that air is the medium of music but others would perhaps, prefer to say that sounds are the medium of music. If you describe stone or marble as the medium of sculpture, you will not be meaning exactly the same thing as when you declare that colours are the medium of painting. You cannot write the following without involving the fallacy of the term medium :

Air : Music :: Oil (or water) : Painting

And then again, adapting Sir B. Brodie who wrote, “The seal..... except through the medium of his whiskers.....may be said... (to have) no sense of touch at all”, we say, ‘The human being except through the medium of his ears may be said to have no sense of sound at all’, we shall be using the word medium in yet another sense. Yet again, we can say that Shakespeare or

Dante expressed his vision of life through the medium of poetry and equally confidently assert that while Wordsworth worked in a poetic medium, Shakespeare did not,—using the word medium in the sense in which Mathew Arnold speaks of the repulsive nature of Burns's medium (sense 4.b.). And none of the above senses will fit Dr. Bosanquet's idea of "the wall of a cave, or a plate of gold, or a scrap of paper" being a medium.

This apparent anarchy of significations and the somewhat indiscriminate use of the term in art criticism, now in one sense and then in another, is responsible for much of the reigning confusion in our attitude towards art. And yet, the anarchy or rather the multiplicity of the meanings is not arbitrary in the final sense, and if we hold fast to the central idea involved in them, we shall be in a fair way to accomplishing our object which is no other than the determination of the content of the concept of 'medium of art'. The central idea is, as we can easily see, that medium is the middle term of any process that is tri-terminal. But all processes in this world are continuous, that is, for the sake of analytical treatment, multi-terminal. It then becomes a question of relative tri-terminality. We can pick out any group of three terms and call the middle term, medium. We shall be more or less correct according as we denote more or less accurately the lines separating the terms. To apply this in the sphere of art, that is, to processes which bring into being works of art, we shall have first to be clear about the first and the third terms. Once the exact nature and limits of these are determined, there should be no great difficulty about the middle term. It will then become apparent that the ambiguity in the use of the term medium in art criticism derives not from any ambiguity or confusion inherent in the very concept of the middle term, but from a failure to demarcate clearly the preceding and succeeding terms and to fix their boundaries, and from a muddle over ascertaining their proper nature and hence the nature of the entire process; so that hazy, irrelevant or only secondarily relevant items creep into their contents to the utter ignoring of the strictly, primarily and essentially pertinent ones. It is out of this ambiguity in the initial and end terms that the various problems of art criticism above referred to arise.

To illustrate in a general way: Air is correctly described as medium (sense 4. a.), if the first term is the object that makes the sound, say, a disc on a gramophone, and the third term is the ear or the auditory diaphragm of the listener in his easy chair. But if you take the singer to be the first term and the listener to be the third term, then the disc becomes the medium, (sense 5.). And if

useability is the third term and pigment the first term, then oil or water will be the medium, (sense 6.). And so on.

In order to fix the true meaning of the first and the third terms and more particularly of the end term, how then shall we visualise the aesthetic process? I shall start with what seems to me to be the popular conception of it. It might be represented somewhat as follows :—

Artist : Medium : Work of Art

We have, as I said just now, to analyse the third term more particularly. For it is in relation to an end that something is a medium. But it would be helpful to analyse the first term first, as that may facilitate our approach to the other problem. Now, so far as the artist is concerned, it is a common fashion in criticism to aver that he expresses his whole personality in art. That is to say, in the aesthetic process the whole personality of the artist is at work. This proposition is, however, rather misleading and the treacherous term is 'personality'. For personality is not a unity, although it may be integrated. It has various aspects and these aspects begin and grow out of the varied commerce of a sentient being with the world of things. The various aspects of a personality are related to the various aspects of the world of things and have their primary relevance in these specific relations. The artist at the same time that he is an artist, is also a human being, disturbed by animal appetites, conditioned by social responsibilities, indulging in political predilections, and perhaps, stirred and agitated by moral and religious aspirations or cravings. Some or all of the aspects of his personality thus developed might be secondarily operative in his work. But none is primarily relevant. If he cannot keep them out altogether, that is because he is a human being and not a God. And he is a greater or a lesser artist in proportion as he can or cannot, deliberately or instinctively, prevent them from interfering with the operation of that aspect of his personality by virtue of which and of which alone he is an artist. However divergent the rest of the aspects, they do not matter in works of art. All artists will be equally eminent in spite of the divergence. A republican will paint a different picture from that of a monarchist, and an atheist from that of a theist. A commercial age will require different architecture from that of a religious age. The dance in which Negroes will celebrate a religious ceremony may not be the same as the dance of an Indian Gopi and Krishna. In all these cases, if, as I insist, the artists succeed in catching fire from the irrelevant aspects without letting it burn out the expression of the relevant aspect, they are all equally great. We might then accept

the proposition about the whole personality of the artist being at work in this sense, namely, that this supremely relevant aspect takes possession of the whole being of the artist at the moment at which he is in the act of executing his work to the suppression of others which are or might have been, as it were accidentally, operative.

What then, is this aspect which alone is supremely relevant in works of art as works of art? To answer this question we must realise that it is in its pronounced aesthetic sensibility that the temperament of an artist differs from that of common men. The artistic temperament might be called an attitude but for the unfortunate suggestion of artificiality which that word conveys; whereas the aesthetic sensibility is an innate characteristic of the mental organisation of the artist. Some eminent critics have found difficulty in accepting a specific aesthetic emotion. Their difficulty has, I believe, more to do with the attribution of a specific emotional character to an experience which is an undoubted fact rather than with the very existence of that experience itself. This emotion, I am certain, is a function of the aesthetic sensibility. The aesthetic sensibility is a peculiarly keen and an exceptionally ready sensitiveness to sensuous impressions. Its differential quality resides in an acute, even poignant, delight in these sensuous impressions *as* sensuous impressions, in and for themselves, unencumbered or unadulterated by those accretions of thought construction which the growing human mind develops as it grows and with which it invests the sense impressions for the more efficient dealing with environment. This sovereign delight in pure sense impressions without even so much as a suspicion of what it 'means', is a fact of consciousness and a datum of the profoundest, almost absolute, significance for aesthetics; and nothing can do more harm, both to aesthetic theory and to artistic creation, than a disparaging or a decrying of it as is the fashion, or a sublimely supercilious ignoring of it as is the besetting temptation.

In such matters, however, 'an inch of illustration' is more illuminating than 'a yard of theorising'. I shall, therefore illustrate my thesis with a few simple examples. A tree is covered with leaves of a rich green. To the artist, supposing him to be a painter, the significance of the tree would lie in this colour, in its lines and its form. It is the greenness and the form of lines, masses etc. that will hold him spell-bound. That the green foliage would offer a shady refuge to a weary traveller from the burning heat of the tropical sun is nothing to him *as an artist*. A dish of pomegranates will fill him with silent rapture at the vermillion and white of the seeds; the thought that they might stop the hunger contractions

of his stomach may not even enter his mind. And although, if he happens to taste the fruit, it may turn out to be as disgusting to his palate as it was alluring to his eyes, that will not diminish one jot or tittle of his aesthetic joy. As Ardengo Soffici, an Italian art critic who is himself a painter and, therefore, ought to know, puts it, the painter ".....non vede nella realtà stessa che un tessuto di elementi pittorici.....". This is most strikingly evident in the case of music. But I must hasten to add that it is not the same thing as Dr. Bosanquet's 'easy beauty'. Heightened to a passionate apprehension of the various aspects of the universe through the sense organs in their rarest possible intimacy and purity, this aesthetic sensibility becomes the making of the artist. It is in this sense that art reveals truth which is reality independent of accidental human experiences. It is in this sense that the doctrine of child-like vision is true.

Aesthetic sensibility, delight in sense impressions purely for their sensed qualities, is then the first term in the aesthetic process. Now what shall we say about the third term? This is popularly taken to be 'work of art'. This term again, is obviously ambiguous. For that which we call a work of art is analysable into a physical thing having properties which it possesses in common with several other physical objects which are not works of art at all, or are works of a different art. A statue has the colour of its material, but colour is not what sculpture concerns itself with. A picture has weight and mass and can be felt, but felt touch qualities are not what we admire a picture for. Music involves bodily movements, but is not on that account judged as dancing is judged. And so on. Again, a work of art is a saleable article, and as such has economic value. Thirdly, the artist lives in a particular social environment which would offer him suggestions; so that European painters will paint men wearing European clothes or Christ episodes; Indians will paint men in dhoties and turbans, or one or other of their thousand deities; and the Chinese will paint men in Chinese 'uniform' or carve wonderful Bodhisattvas. Lastly, as in the case of modern Russian art, the work of art may have propaganda or 'message' value. All these aspects of the work of art satisfy different ends. But none of these can be the third term in the aesthetic process for none of these satisfies the aesthetic sensibility of the artist which is our first term. Secondly, none of these can be our third term because none of these is an un-variable or an indispensable. The third term then, can only be that which is a necessary attribute of a work of art; that without which it ceases to be a work of art while still satisfying all the other ends; that which is common to all works of art irrespective of the divergence

incident to the dissimilarity of other ends which they might severally be pursuing. This special attribute of works of art is beauty.

But, 'what is Beauty?', as a serious art Pilate might ask. I shall content myself at the moment with describing it as that quality or power by virtue of which a sense impression attracts a person independently of any 'meaning' which may happen to have been ascribed to that sense impression. In other words, it is the power of fascination of a particular aspect of the world of things, such as sound, colour, movement etc. *as* that aspect, that is, *as* sound, colour, movement etc. and nothing besides, not implying any content of meaning which becomes as it were extraneously attached to it through dealing with it, that is, through active human experience. The revelation of this fascination is what the artist, so long as he remains an artist, that is, in so far as he is surrendering himself to his aesthetic impulse and letting it work itself out in the material provided, aims at. This is, therefore, the third term in the aesthetic process.

To describe the aesthetic process briefly: A peculiar and uncommonly acute as well as exclusively absorbing sensitiveness to a particular aspect of the universe, using *that* aspect to discover not-commonly-felt fascination, charm or beauty inherent in that aspect. The medium is the aspect of the universe; the end is the revelation of the beauty dwelling, unseen by others, in that aspect; and the method used is that of 'satisfying organisation', that is to say, organisation in accordance with formal principles, such as contrast, rhythm, balance etc. I have used the word revelation in the foregoing description. But to avoid any suggestion of a mystic element, I shall add that the aesthetic process is akin to perception or, more strictly, to apperception. This would also serve to distinguish it from thought construction, which it is likely to appear from its analytical statement attempted above. It is not necessary to consider the question of degrees of excellence in products when the underlying process is the same. The answer would not be difficult to find with the help of the concept of 'higher unit mechanisms' with which the psychology of learning has made us familiar.

Failure to make this distinction between the medium in which an artist works, which is an aspect of the universe, and his materials, physical objects like stone, oil paint etc. which are much more besides, is due to the tyranny of the eye: it has obscured many of the problems in aesthetics; it is responsible for the now fashionable emphasis on embodiment and communication; and

recently it has served to elevate the materials into a false importance. Dr. Bosanquet, not having analysed the concept of medium threadbare, comes to the conclusion that, "The differences of the great arts then are simply such differences as those between clay-modelling, wood-carving and wrought-iron work, developed on an enormous scale." This, I humbly submit, is a false principle of differentiation, deriving as it does from an unimportant difference in the materials used; whereas the true ground of difference between the different arts is derived from their media, that is, the aspects of the world of things which they reveal; or, in other words, the right kind of differentiation should proceed by a consideration of the sense organ or sense organs which become involved in their appreciation. The nature of the materials, whether clay or marble, oil paint or water colour, a fiddle or a piano etc., the artist will have to take into consideration and adapt his technique to. But this is neither an essential nor a very difficult part of the artist's work, provided he is inspired by supreme delight in that particular aspect of the universe which is the chosen province of *his* art, and is firmly controlled by the principles of formal organisation. It is only non-artists or those who have not thought about the matter, that are intrigued by the materials. This is what a real artist says: "But good or bad, concrete is not the only material even in an industrial world. I have done carvings in concrete and am willing to do as many more as I am asked for. But stone, whether natural or artificial, and wood and all kinds of metal are also available. I do not carve in stone for aesthetic or sentimental reasons but simply because that is the material to hand or the material ordered by my customers...". (Eric Gill in a letter to the *Criterion*, October, 1934.). That is to say, provided the carver has the proper aesthetic feeling, it does not matter what his material is. Aesthetic feeling is feeling aroused by a sensed quality independently of its meaning. This, in the case of a carver, is line and felt, tactile solidity as distinct from visual solidity. Given this aspect of line and cutaneously sensible solidity, let his materials differ in other aspects as they will. That would only raise a question of technique. This is shown by the history of Indian craftsmen. Describing Asokan sculpture, Vincent Smith observes, "Many details (of the Asokan sculpture) indicate that the artist in stone followed the example set by his fellow craftsman in wood and ivory. Indeed, ordinary Indian usage seems to have favoured the exercise of his skill by a carver in any material that came to his hand. If Asoka insisted, as he did, on his statuary and reliefs being executed in enduring stone, he was able to utilise the services of skilled Indian workmen

accustomed to work in more perishable materials, who were clever enough to adapt their technique to the permanent medium." Commenting on the Second Quadriennial Exhibition of Italian Art held in Rome, in the *Popolo d'Italia* of 5th February 1935, Raffaele Calzini alluded to the remarkable Italian sculpture, Arturo Martini, and related that, "Tempo fa Arturo Martini mi esprimeva il desiderio di fondere nel vetro il suo monumento ad Ippolito Nievo." It was in a similar manner that Botticelli could utilise his gold engraving technique even in painting. And musical composers have not seldom found auditory images of instrumental music or singing rather a hindrance than a help.

The point I wish to make is that the nature of the material, that is, the aspects other than the strictly relevant aspect, is only one of the many things, e.g., the necessity of earning a living and therefore the nature of market demand, his intellectual or other prepossessions, the nature of tools available etc., which the artist will have to take into consideration without letting his art become subservient to them. If certain forms are not realisable in marble while they are realisable in, say, clay, that constitutes no more valid an argument than that a statue cannot be made to dance. You cannot by taking irrelevant impossibilities into account extend the scope of relevant attributes, thus. You cannot make medium synonymous with material. Interest in the irrelevant aspects might be common to the artist and other men. But it is his unbounded, pure joy in his medium, that is, in that particular aspect of the universe which is the domain in which *his* art moves, that makes *him* and *him alone* an artist,—a painter, a sculptor, a musician, an architect and so on.

To perceive that medium is an aspect of the world of things apprehended through a sense organ, significant per se and without any addition of knowledge-content or 'meaning', is to take the first step towards putting Aesthetics on a scientific basis. Since the aspects of the universe are apprehended through the sense organs, there will be as many aspects as there are sense organs. To each sense organ will then correspond one pure art. Then there will be different orders of arts according to their purity. Relative purity will depend upon the number of sensed aspects involved. The greater the number of these, the less pure the art. The reason for this can be stated thus; lateral distribution of mental energy involves less keen vertical penetration. By attending to two aspects at once you fail to imbibe the whole significance of either one. You are impeded in the full enjoyment of one, and therefore of completely understanding that one, because you are distracted

by the other. You get the maximum of joy if, whatever the Constant of your mental energy, all of it is directed into one sense channel. We shall thus be able to evolve a new and a more scientific ascending and descending order of fine arts, at the top of which will be music and at the bottom poetry. The mighty poets will resent this, for they have all along arrogated to themselves a prerogative, premier position on the Mount of Parnassus. But they have been, directly or indirectly, responsible for so much of what has vitiated art appreciation and aesthetics that they can hardly complain if Nemesis at last overtakes them.

B. S. MARDHEKAR

THE 'UNCONSCIOUS' THROUGH THE AGES.

(*Concluded.*)

The first part of this paper¹ may be epitomised thus : To facilitate the analytic treatment of the subject, we distinguished mainly between two types of unconscious mental activity, viz., (a) the psychological, and (b) the metaphysical, with a subdivision of the former into (i) the innate, (ii) the acquired, and (iii) the Freudian. Then came a sketch of the New Psychology followed by a statement of the purpose and procedure of the whole essay.

Here we took up the subject proper. We reviewed the situation from Protagoras to Aristotle—the Ancient Period of our plan—and concluded that a gradual but distinct advance is noticeable in the evaluation of the extra-conscious mental activity as a factor of vital importance in the genesis and the variegated growth of human life.

And now we proceed to ascertain the attitude of the moderns towards the 'unconscious'². For ready reference, I may here repeat the rest of the plan which is as follows.

I. B. SECOND PERIOD : MODERN AND CONTEMPORARY.

- (a) (1) Leibnitz (1646-1716 A. D.).
- (2) Herbart (1776-1841 A. D.).
- (3) Schopenhauer (1788-1860 A. D.).
- (4) Hartmann (1842-1906 A. D.).
- (b) Samuel Butler and others including Henri Bergson and Frederick Myers.
- General Considerations.

II. UNCONSCIOUS OF THE NEW PSYCHOLOGY.

- (a) Its Theoretical Aspects.
- (b) Its Practical Aspects.

III. RETROSPECT.

I. B. SECOND PERIOD : MODERN AND CONTEMPORARY.

About the philosophers included in this section, I have to add a preliminary remark. There are writers who have already taken notice of some of these thinkers as forerunners of Freud in respect of his theory of the unconscious. But my excuse for their mention here is that the very historical perspective which I have so

1. Published in the January issue of this Journal.

2. For the aim of the present enquiry see the first part

far adhered to necessitates an account of their contribution to the understanding of the relation which subsists between the unconscious and conscious sides of our mental life. It is also necessary to guard against a possible confusion. The division into (a) and (b), it must be remembered, does not correspond to modern and contemporary respectively. It rests, more or less, on the relative importance of the thinkers from the point of view of our aim. It is on the same ground that the unconscious of the New Psychology is accorded a separate treatment.

(a) (1) *Leibnitz (1646-1716 A.D.)*.

Leibnitz is the first philosopher to invest the term unconscious with a definite technical sense. It is a concept which characterises both his metaphysics and psychology. Accordingly it may be distinguished in two ways: (i) the primary and the comprehensive which is the metaphysical; and, (ii) the derivative and the restricted which is the psychological.

(i) *The Metaphysical Unconscious*.

The doctrine of monads, the principle of pre-established harmony, and the law of continuity are the three fundamental principles which govern Leibnizian thought in all its aspects.

Satisfactory solution of the riddle of the universe, Leibnitz held, depends entirely on an appropriate unit, a unit which must be real and indivisible in one. To be real, it cannot be quantitative, for then it would fail to satisfy the other condition; to be indivisible, it cannot be a particular in space and time, for the Reality of Leibnitz is not an aggregate but a genuine *continuum*, the Reality which somehow expresses itself through each of its parts and can be related to it only dynamically. Such a unit can only be conceived in terms of quality, intensity, or rather force. This unit which tries to express the whole and become it necessarily implies certain other essentials. It has Perception³ and Appetition⁴, characteristics which may crudely be described as 'knowing' and 'willing'. Perception is the quality in virtue of which the 'simple substance', or the 'metaphysical point', represents an aspect of the universe, while 'appetition' keeps it continually striving to realise the possible. It is this unit which Leibnitz dubs a 'monad'.

3. i. e., 'The passing condition which involves and represents a multiplicity in the unit (*unite*) or in the simple substance'. Leibnitz's *Mondology*, § 1. Unless otherwise stated, my references to the works by Leibnitz will be to Latta's edition, Oxford, 1898.

4. i. e., 'The activity of the internal principle which produces change or passage' from one perception to another'. *Ibid.*, § 15.

A monad is essentially individual, a unique representation of the whole universe. 'Every monad is, in its own way, a mirror of the universe'⁵. It is an entirely self-subsistent microcosm. 'The monads have no widows through which anything can come in or go out'⁶. They are mutually exclusive. There is, however, 'the pre-established harmony between all substances since they are representations of the same universe'⁷. Every monad again is in a state of perpetual flux. It 'is subject to change, and further that this change is continuous in each'⁸. Thus indivisibility and reality imply unity, activity and continuity as the three distinguishing characteristics of a monad.

There are monads of all degrees of diversity. All the contents of the world are classified into three big classes of monads on an ascending scale, from bare or unconscious monads to rational or self-conscious monads, according to their representative capacity which varies from *petites perceptions* (little or confused perceptions) to *apperception*. By the latter term, Leibnitz means *consciousness* or the reflective knowledge of perception, and further adds that it 'is not given to all souls nor to the same soul at all times'⁹. And though no two monads can be identical in their nature, there prevails an absolute psychic unity between the lowest and the highest¹⁰. Men, animals, plants, fossils, and the so-called dead matter,¹¹—all are thus linked up in a chain headed by *Monas monadum*, the highest of monads, which is God. This God, we are told, 'governs minds (esprits) as a prince governs his subjects, and indeed as a father looks after his children ; while, on the other hand,

5. *Ibid.*, § 63.

6. *Ibid.*, § 7.

7. *Ibid.*, § 78. cf. 'He who sees all might read in each' (monad) 'what is happening everywhere, and even what has happened or shall happen observing in the present that which is far off as well in time as in space'. *Ibid.*, § 61.

8. *Ibid.*, § 10. This is one of the many ways in which the law of continuity operates.

9. Leibnitz, *Principles of Nature and Grace*, § 4.

10. We have here both the negative and the positive sides of the law of continuity, viz., the law of the Identity of Indiscernibles and the principle of the serial gradation with an imperceptible qualitative difference between its constituents.

11. Leibnitz sees nothing in the world which can be called 'unconscious' in the sense of being 'inanimate,' i.e., 'incapable of being aware of something at some time'—one of the meanings distinguished by C. D. Braad (*The Mind and Its Place in Nature*, London, 1925, p. 354).

he deals with substances as an engineer works with his machines'¹². He is all activity, absolute perfection. Next to Him stand the rational monads, human beings; then follow in their respective order, the other members of this hierarchy of monads. 'All nature' thus 'is a plenum,'¹³ full of life.¹⁴ 'There is nothing fallow, nothing sterile, nothing dead in the universe, no chaos, no confusion, save in appearance, somewhat as it might appear in a pond at a distance, in which one would see a confused movement and, as it were, a swarming of fish in the pond, without separately distinguishing the fish themselves'¹⁵.

Leibnitz thus is a thorough going mentalist and his system an attempt to establish the omnipresence of mind in nature. There is nothing which can be called lifeless. Even a stone has perception, only that it is unconscious. Unconscious perception, in other words, is not the absence of consciousness but the limit of consciousness. Besides unconscious perception, there are two other degrees of perception, one higher than the other, which characterise the conscious and the rational monads respectively. These are conscious perception and apperception. Leibnitz's metaphysical theory explains, in this way, the noumenal variety of the world in terms of various degrees of clearness and distinctness of perception. And, the concept of the 'unconscious' as entering into this metaphysical explanation of the universe exemplifies, in a way, the unconscious mental activity of the metaphysical type. The bearing of the 'unconscious' on the 'conscious' and the 'self-conscious' perception, and the continuity which makes possible this perceptual activity show us the scientist in Leibnitz. His was the first attempt to demonstrate the pressing need of penetrating into the individuality and indistinguishability of things for the onward march of science. Its psychological value lies in its principle of all-pervading activity and the subversion of the traditional concept of consciousness¹⁶.

12. Leibnitz, *New System*, § 5. Referring to this distinction 'between the souls of animals and the spirits of men', Ward rightly observes that Leibnitz in admitting this difference, which virtually amounts to a difference in kind, disregards 'his cardinal principle of continuity' (*Realm of Ends*, 2nd ed., Cambridge, 1912, p. 91).

13. Leibnitz, *Principles of Nature and Grace*, § 3.

14. *Ibid.*, § 1.

15. *Monadology*, § 69.

16. Descartes' 'consciousness,' for instance, is Leibnitz's apperception. It is this feature especially which makes Leibnitz the forerunner of Herbart, Schopenhauer, and Hartmann,

(ii) *The Psychological Unconscious.*

It is mainly the *New Essays on the Human Understanding*¹⁷, Leibnitz's rejoinder to Locke's famous *Essay Concerning Human Understanding*¹⁸, which embody his views on psychological and epistemological problems. The central question at issue between Locke and Leibnitz is 'whether the soul, in itself, is entirely empty, like a writing-tablet on which nothing has yet been written (*tabula rasa*),.....and whether everything that is inscribed upon it comes solely from the senses and experience; or whether the soul originally contains the principles of several notions and doctrines, which are merely roused on certain occasions by external objects'¹⁹. Leibnitz's reply to the first part of the question is in the negative, to the second in the positive. Leibnitz strikes a via media between two almost opposite points of view, of Descartes and Locke respectively, by postulating a view of mind endowed, at its birth, quite independent of the senses, with certain dormant or innate ideas which the senses 'awake' but do not 'create'. The senses and what we call the phenomenal contents of the world thus play their part in the process of acquiring knowledge. Senses provide occasions for ideas, rendering the latter a very substantial help to become explicit, but creative power they have none. Sense knowledge is confined to particulars, it is real but very partial²⁰.

In the process of knowledge a momentary sense experience is not followed upon immediately by an explicit awareness of the innate ideas. Sense perception and apperception of innate ideas are two ends, start and finis respectively, of a serial process of awakening on an ascending scale with reason at the helm—reason which is the distinguishing characteristic of man. Leibnitz thus

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17. The *New Essays* were written about the year 1700, but were published in 1765, 49 years after the death of the author. I shall rely mainly on the Introduction to this work which gives a good summary account, by Leibnitz himself, of the whole argument.
 18. Locke's position, so far as it concerns us here, may crudely be stated as follows. As an empiricist, Locke holds that the mind, at birth, is an 'empty cabinet' without any property of its own. Experience is the home of our ideas which are distinguished as simple and complex. The former are to be ascribed to sense, i. e., perception, the latter to a further stage, viz., reflection. It is interesting to note, from the psycho-analytic point of view, that, for Locke, environment, as the store-house of the occasions of our experience, comprises even the pre-natal period. (For these points see Locke's *Essay*, Fraser's ed., Oxford, 1894, pp. 48ff., 184ff.)
 19. Leibnitz, *New Essays*, p. 360.
 20. *Ibid.*, p. 362.

maintains that 'we are, so to speak, innate to ourselves' and the fact that we cannot consciously perceive what is innate in us is to be attributed to our '*distractions and wants*'²¹. To illustrate the distinction between the *tabula rasa* view of mind and his own, Leibnitz likens mind to 'a block of veined marble' particularly susceptible to the figure of Hercules rather than any other. In such a stone, he says, Hercules may somehow be said to be innate, though labour would be needed 'to uncover the veins' and get the figure out. 'It is thus', he proceeds, 'that ideas and truths are innate in us, as natural inclinations, dispositions, habits or powers (*virtualités*), and not as activities (actions), although these powers are always accompanied by some activities (actions), often imperceptible which correspond to them'.²²

The main result of Locke-Leibnitz controversy has come to be this. For Locke the creative agency lies exclusively in sensory experience, mind being a derivative something; for Leibnitz activity is the essence of mind or soul, the occasions of experience being merely of secondary importance. Leibnitz maintains that mind always thinks, though it may not be conscious of the process all the time. We may often be without apperception and reflection, but we are never without perceptions, perceptions which are vague and confused. To explain the process from the *petites perceptions* (which are the confused or unconscious perceptions) to *apperception* or self-consciousness, Leibnitz specially chooses 'the illustration of the moaning sound of the sea, which we notice when we are on the shore'. 'In order to hear this sound as we do, we must hear the parts of which the whole sound is made up, that is to say the sounds which come from each wave, although each of these little sounds makes itself known in the confused combination of all the sounds taken together, that is to say, in the moaning of the sea, and no one of the sounds would be observed if the wave which makes it were alone. For we must be affected a little by the motion of this wave, and we must have some perception of each of these sounds, however little they may be; otherwise we should have perception of a hundred thousand waves, for a hundred

21, *Ibid.*, p. 365-66. Italics mine.

22. *Ibid.*, p. 367. The distinction which Leibnitz makes between innate ideas and the occasions of experience may well be compared with the interpretations of Plato's doctrine of reminiscence and of Aristotle's bipartite division of reason respectively which we have followed (see the first part of this paper). Leibnitz himself derives, in this connection, an authentic support from the rational part of Plato's doctrine of reminiscence (p. 368).

thousand nothings cannot make something'²³. Leibnitz applies this logic to the working of mind in general. Even during the so-called profoundest sleep, we are perceiving, may be very feebly, for 'we should never be wakened by the greatest noise in the world if we had not some perception of its beginning which is small'²⁴.

It is not very easy to ascertain the exact nature of the relation of the *petites perceptions* to the innate ideas. Crudely, it may be stated as follows. Human soul is a monad and as such it is the ultimate source of all its ideas. Ideas thus are all innate. But to know the existence of these innate ideas, mind has to pass through a process which may be described as the process of knowledge. It is a process of progressive becoming, from confusion to distinctness, a sort of organic growth. It is only in this way that ideas can become clear and distinct. Confused perception then is an internal state, a vague representation of things outside mind with which the mind comes into contact during the course of experience. Confused perception, in other words, grows into a clear and distinct idea with the help of experience.

Leibnitz brings out clearly the role of *petites perceptions* in the mental life of an individual in the following passage. '*Petites perceptions* have...through their consequences an influence greater than people think. It is they that form this something I know not what, these tastes, these images of sense-qualities, clear in combination but confused in parts, these impressions which surrounding bodies make upon us, who contain infinity, this connexion which each being has with all the rest of the universe. It may even be said that in consequence of these *petites perceptions* the present is big with the future and laden with the past, that there is a conspiracy of all things.....and that in the least of substances eyes as penetrating as those of God might read the whole succession of the things of the universe'²⁵. It is these unconscious perceptions,

23. *New Essays*, p. 372. William James refers to this part of Leibnitz's argument as 'an excellent example of the so-called "fallacy of division"'. See his *The Principles of Psychology*, Vol. I, New York, 1890, p. 164. For a similar view, see also Broad, *Mind and Its Place in Nature*, London, 1925, pp. 406-408.

24. *New Essays*, p. 372. The line of argument which Leibnitz adopts here illustrates how the metaphysician or the Psychologist in Leibnitz is victimised by the mathematician in him—a fact which affects a good deal Leibnitian thought in general.

25. *New Essays*, pp. 372-73. James Ward asks the psychologist to ponder over these observations. He himself refers to them in explaining the subject-object relativity and the idea of the presentational *continuum*

Leibnitz argues, that constitute 'the identity of the individual' and explain the 'wonderful pre-established harmony of body and soul and, indeed, of all Monads or simple substances'²⁶. The source of all actions which are not preceded by any conscious deliberation on the part of the agent is to be found, we are told, in *petites perceptions*. And what Leibnitz adds is more important: '*They cause that uneasiness which I show to consist in something which differs from pain only as the small from the great, and which nevertheless often constitutes our desire and even our pleasure, giving to it a kind of stimulating relish*'.²⁷ Will, which strives after the Good, also has its source in the region of these *petites perceptions*, the unconscious and the unnoticed elements that collectively form the breeding place of desires in general. 'In a word', Leibnitz writes, '*unconscious (insensible) perceptions are of as great use in pneumatics as imperceptible (insensible) corpuscles are in physics; and it is unreasonable to reject the one as the other on the ground that they are beyond the reach of our senses*'²⁸.

We may now try to put the views of Leibnitz about mind and its working in general terms. Leibnitz with all his talk about unity and continuity, distinguishes sharply between souls and spirits, i.e., animals and human beings. It is a distinction of kind rather than of degree. This becomes clear, for instance, from the difference he makes between the nature of the relation of God to men and animals respectively. He speaks of Him as a prince or a father in relation to men and 'as an engineer in relation to animals. Moreover, reason, we must remember, is the monopoly of minds only. Spirits (i.e., minds) alone have the power of self-consciousness and enjoy the status of dominant monads on which depend those colonies of monads, our bodies.

The implications of Leibnitz's theory of the unconscious, from the psychological point of view, are manifold. Mind is innate to itself: on this view of mind, we may look upon the hypothesis of the existence of innate ideas in an implicit state and in absolute independence of the sensory experience as the innate Unconscious.

which extends indefinitely beyond what can be clearly perceived, 'The problem for psychology', according to Ward, 'is to ascertain the successive stages in the advance from one form of experience or knowledge to the other'. (*Psychological Principles*, Cambridge, 1918, pp. 30-33.) See also Hoffding, *Outlines of Psychology*, tr., London, 1912, p. 78.

26. *New Essays*, pp. 373-74.

27. *Ibid.*, p. 375.

28. *Ibid.*, p., 276.

What the senses do is to help reason to work the transition from the implicit to the explicit²⁹. This variety of the Innate Unconscious cannot possibly be described as the Hereditary Unconscious. In no way it is possible to offer, on scientific lines, a demonstrative proof of what we have here called the Innate Unconscious in connection with Leibnitz's view of mind. The most that a sympathetic reader of Leibnitz can do is to point out to geniuses like Srinivas Ramanujan, F. P. Ramsay, and Leibnitz himself³⁰.

Irrespective of the possibility or otherwise of the existence of the Innate Ideas, we may consider what may be called the Acquired Unconscious in the philosophy of Leibnitz. However insignificant may be the knowledge of the subconscious processes in the eyes of the psycho-analysts, it is to the great credit of Leibnitz that he did a pioneering work in presenting to the philosophic world a tolerably consistent theory of their working and importance in the mental life of an individual. Consciousness, he showed, is just a fleeting phase of mind, but it is the subconscious which constitutes the identity of the individual, subsisting through thousand and one imperceptible influences to which our minds are susceptible every moment. The sustenance of the process of cognition depends upon two factors, viz., the unconscious assimilation and the recognition of what is already acquired. Perhaps it is this aspect of Leibnitz's thought which Flugel has in view when he observes: '*Petites perceptions* constituted the first clear statement of anything approaching the modern doctrines of the Unconscious'³¹.

29. It should be observed that, like Plato and Aristotle, for Leibnitz too reason, in one form or another, constitutes the essence of man. Furthermore, all the three hold that the perceptual process leads to the conceptual—for Plato it may lead to the knowledge of ideas, for Aristotle it may culminate into a life of contemplation, for Leibnitz it may bring about the explicit awareness of The Innate Ideas

30. I have already referred to Montmasson's admirable study, *Invention and the Unconscious* (London, 1931) on certain points (first part). At this stage of study of Leibnitz's psychology, two observations of Montmasson are worth mentioning. First, 'Consciousness is the immediate, spontaneous, or reflective knowledge of the internal states and phenomena of the mind by the mind itself and by the mind alone' (*Ibid.*, p. 3). Second, 'All of us, in various degrees, obey the same psychological laws, and invent to a certain extent. But in the case of the majority, the creative work remains obscure and nameless, because it does not attain a sufficiently high degree. The true invention is a maximum point, the inventor a hero of truth..... In the pursuit of progress, good minds may reach the peaks' (*Ibid.*, p. 25-26).

31. *A Hundred Years of Psychology*, Duckworth, 1933, p. 18.6

Leibnizian Unconscious, however, is at great variance from the current Freudian concept of the Unconscious. The 'unconscious' of Leibnitz is active, shapes a good deal our conscious life and thus directs the ordinary course of experience, while that of Freud is '*active and unconscious*', its revival being possible only with the help of a Freud. If we describe the former as the 'normal unconscious', the latter may be called the 'abnormal unconscious'. The 'unconscious' of Leibnitz, in other words, is, in a sense, the 'preconscious' of Freud.

It would then be contended that in respect of their theories about the unconscious, Leibnitz and Freud are poles apart. But in dealing with the problem of the unconscious at least, we run a risk if we take things at their face value. We must probe deep to get to the core of things. Leibnitz, we must remember, speaks of the 'unconscious' when he is replying to Locke from within the four walls of his study. Freud, with Breuer preceding him, strikes upon the 'unconscious' when he is treating abnormals in a mental hospital. True, their findings, equally as their references, widely differ. This difference is an established fact, but the question is whether it is totally irreconcilable.

The gulf which appears to separate the two views is far from being impassable. Two observations of Leibnitz, selected almost at random, would make this point clear. First, the one (already cited above: the italicised remark, p. 109) where Leibnitz shows the causal relation of the *petites perceptions* to the condition of 'uneasiness'. The other is about the wonders of dreams: 'We invent without trouble (but also *without willing it*) things which in our waking hours, we should have to think long in order to hit upon'³². To me, these observations appear to be so very rich with far-reaching implications that I can conceive of no possible reason why Psycho-Analysis should not have begun its life two hundred years earlier only if Leibnitz had the privilege of enjoying the stimulating company of the neurotics. As it is, however, Leibnitz and Freud stand quite close in two very important respects. Both believe in the principle of activity as applied to mind, and find in what they individually call the 'unconscious' the explanation of the inexplicable.

(2) *Herbart (1776-1841 A. D.).*

Herbart shows Freud on the horizon. If Aristotle laid the foundations of scientific psychology, Herbart fathered what may be called Independent Psychology. Aristotle asserted the existence of Psychology, Herbart claimed for it an independent status. It is

32. Leibnitz, *Principles of Nature and Grace*, p. 424. Italics mine.

Herbart who inaugurated the systematic movement to place Psychology on a par with other sciences. Naturally so pioneering a work cannot fail to make a distinct advance in respect of the 'unconscious', which, all along the development of Psychology, has been forcing the recognition of its importance on the imagination of scholars. As Boring observes: 'Leibnitz foreshadowed the entire doctrine of the unconscious, but Herbart actually began it'³³.

All new movements show traces of their past. It should not surprise us in the least if Herbart, quite knowingly, plays a metaphysician in propounding his psychological doctrines. He postulates as the subject of mental life a soul which is simple but active. We are further told that this soul is a 'real'³⁴—a psychic 'real'—among other 'reals'. It is unknown and unknowable. It is the source of the first activity as also the agent which renders the unity of the individual possible. Self-preservation is its essence. That is, so far as it can be broadly stated, the metaphysics of Herbartian psychology.

Herbart starts with experience as his basis and tries to make psychology a science by developing his theory on mathematical lines. An inner state or states of mind would be, according to Herbart, the function of the variety of external conditions. Objective disturbance followed by a subjective reaction goes to make what we call experience³⁵. The explanation, which Herbart offers, of the interaction between the psychic 'real', viz., the soul, and other 'reals', viz., constituents of the outer world, needs to be elaborated, for it contains ideas which form the nucleus of his views about the 'unconscious'.

Herbartian psychology is a science which attempts to formulate and expound a systematic theory of the 'self-pervations' of the soul. Ideas (in the Lockian sense) are the expressions of this tendency of the soul to preserve itself when it is disturbed by other 'reals'. Considered apart from their conditions and interrelations, these presentations or bits of experience are, it must be remembered, 'reals' by themselves, mutually independent, and have a

33. *A History of Experimental Psychology*, London, 1929, p. 246.

34. According to Herbart's metaphysics, our knowledge of things cannot transcend 'appearance', appearance which necessarily implies being, a 'real'.

35. Here Herbart reminds us of Locke, the leader of English empiricism. But in view of the acute differences which distinguish the two psychologies, this common feature loses all its significance. The differences will come out as we proceed.

dynamic force which is manifested in their tendency towards self-preservation. They are thus unalterable by anything external. It is to these self-preserving 'reals' that Herbart attributes the static variety of the world. All change is appearance. Things appear to us different at different times because we see them in different relations. The idea of dependence again is due to our inability to apprehend the reality behind the appearance of things.

Consciousness provides a dancing floor for these active entities, but they have to dance to certain tunes. Definite quantitative principles regulate the interplay of ideas *per se*. At the outset two ways are quite obvious, co-operation and non-co-operation. Likes co-operate, unlikes do not. Non-co-operation means neither surrender nor compromise, it is conflict. Strength of the opponents usually decides a conflict, and Herbart's dynamic forces are no exception to this general rule. Here we are already in the midst of Herbart's theory of the 'unconscious'. What Herbart must explain is the phenomenon of exclusion of ideas rather than of combination, the state of conflict rather than of harmonious blending.

Perhaps Herbart has in mind the nature of human relations when he speaks of the relation between consciousness and presentations. He gives us something analogous to sympathy, apathy, and antipathy, though the analogy is rather crude. The movement of an idea or a presentation incessantly struggling to preserve itself is confined within two extremes, between a state of absolute freedom and a state of entire inhibition. During the course of this movement three relations are possible between presentations themselves, viz., fusion, complication and inhibition. When an in-going presentation is in harmony with that presentation which is on the summit of consciousness, i.e., when they come under the same department of sense *fusion* takes place (red and blue, for instance, fusing into violet); when they have nothing in common either to make friends or to fight *complication* is the result (a colour and a sound, for instance); and fight ensues when there are presentations such that they definitely oppose each other, one striving to suppress the other: this is the state of *inhibition*; inhibition may be said to be complete when the presentations at war are equally strong and balance each other, but if one side is more forcible than the other, the surplus force automatically secures a place in consciousness. Consciousness thus is constituted by an equilibrium of conflicting forces. Inhibited ideas which have not crossed the threshold of consciousness but have been able to keep hovering somewhere above it are still actual and may succeed in getting back into

consciousness as soon as they have gathered sufficient force by uniting with others of their kind to meet the opposing ideas, or else when these latter have become weak enough to be conquerable. Those ideas, on the other hand, which have been pressed below the threshold exist only as tendencies or impulses. But no idea, as we see, is lost or completely destroyed. And what needs to be specially observed is that Herbart, by admitting the possibility of some ideas transforming into impulses or tendencies, subscribes also to the possibility of a double stimulus, external and internal.³⁶

Now the question arises : Consciousness in itself being transitory, what is it that controls all this shuffling of ideas subsequent to the stage of the first activity, soul being just the starter ? It is a group of ideas—‘apperceptive mass’³⁷ as Herbart calls it—which has increasingly gathered enough strength during the psychic life of an individual to dominate, guide and control his psychic activity. This is the ‘ego’³⁸ or ‘I’ which forms the index to the psychic life of an individual.

The foregoing account of the Herbartian psychology leaves no room to doubt that it differs fundamentally from the system which Freud has been developing. This difference, however, should not surprise us in the least, for we must not forget that their very fields of activity as also their purposes are anything but common. The immediate goal of Herbart’s psychology was to build a sound system of education. His was, more or less, an epistemological

36. This discussion suggests a reference to Leibnitz’s law of continuity, the principle of activity, and the doctrine of *petites perceptions*.
37. A term reminiscent of Leibnitz again. ‘Apperceptive mass’ is a relatively stable group of already assimilated presentations which dominates the psychic activity of the individual.
38. Flugel, who takes good notice of Herbart-Freud relation, remarks : ‘Herbart’s ego...bears considerable resemblance to McDougall’s “self-regarding sentiment”, which, for the latter author, is the ultimate determinant both of will and character..... The essential difference, here as with Freud, is that the modern writer is thinking primarily in terms of “instinct”, i.e., of conation. McDougall’s distinction between “emotions” as the affective aspects of instincts, and “sentiments”, as complex and more or less permanent organisations of instincts, seems indeed to have a forerunner in Herbart’s distinction between “emotions” as “transitory variations from the state of equanimity” and “passions” as “rooted desires” of a more permanent character’ (*A Hundred Years of Psychology*, pp. 20-21). McDougall himself observes : ‘Herbart dealt only with *abilities* and ignored the *propensities* from which the former derive the energies that activate them,’ (*The Energies of Men*, London, 1932, p. 195).

purpose, the nurture of the intellect³⁹. Freud, on the other hand, has been developing his theory out of his invaluable experiences acquired during his long service of the suffering humanity. This difference between Herbart and Freud is the same as the difference between cognition and conation, intellect and emotion. But difference is not the only relation which connects Herbart and Freud, for there is also a positive link which joins the two. Herbart's system is characterised by certain features which show to be full of meaning for a student of Psycho-Analysis, features which show that Herbart and Freud are brothers, only that the one thinks while the other feels. The 'threshold of consciousness', for instance, cannot fail to remind us of the Freudian distinction between the pre-conscious and the unconscious, inhibition directly suggests repression⁴⁰, the impulses formed out of the totally inhibited ideas recall the crude impulses of Freud.

(3) *Schopenhauer (1788-1860 A.D.)*.

Leibnitz gave birth to the metaphysico-psychological unconscious, Herbart developed the epistemologico-psychological unconscious, Schopenhauer pioneered the metaphysico-psycho-analytic⁴¹ unconscious. The transition from head to heart, from cognition to conation, from intellect to will, is what constitutes the unique character of the philosophy of Schopenhauer. All the philosophers before him, Schopenhauer contends, placed 'the true being or the kernel of man in the *knowing* consciousness and accordingly have conceived and explained the I, or in the case of many of them, its transcendental hypothesis called soul, as primarily and essentially *knowing*, nay, *thinking*, and only in consequence of this, secondarily and derivatively as willing'⁴². They wandered in

39. 'To secure the reaction of the mind upon what is offered to sense perception' constitutes for Herbart 'the chief object of Instruction.' *Herbarts A B C or Sense-perception*, tr., London, 1914, Eckoff in the preface, p. vii.
40. Hollingworth (in his *Abnormal Psychology*, London, 1931) takes notice of Herbart as the forerunner of Freud in certain respects. For parallel citations on the present point, see p. 141 of the book.
41. The term, as I use it here, is to be distinguished from the 'psychological' by the special stress it lays upon the crude impulses or the primitive instincts. cp. (1) 'The whole trend of Schopenhauer's interest is toward the most fundamental impulses of the animal nature' (Brett, *A History of Philosophy*, III, London, 1921, p. 83). And, (2) 'Schopenhauer opened the eyes of psychologists to the subtle depth and omnipresent force of instinct' (Durant, *The Story of Philosophy*, N. Y., 1927, p. 379).
42. *The World as Will and Idea*, II, London, 1909, p. 409. My references are to the trans. by Haldane and Kemp.

wilderness. Schopenhauer set himself the task of correcting 'this ancient and universal radical error'.

It is in *The World as Will and Idea* that Schopenhauer marshals his attack against the erring ancients. The work has more the character of a romance than of a philosophic system. Windleband's observation that 'Irrationalism came to its full development in Schopenhauer' is a sufficient warning against any attempt to look for science in *The World as Will and Idea*. But science alone does not exhaust sense.

It is humanly impossible, Kant declared, to know the essence of things. Things-in-themselves are beyond the scope of 'knowledge', for in the very attempt to know, the subjective factor enters and distorts the object of knowledge. This view of Kant, Schopenhauer also shares. But he does not stop there. The unknowability of things-in-themselves, Schopenhauer attributes to the helplessness and limitations of Reason. Leave the company of Reason and he promises you a glance of the true nature of things. If there be no royal road to secure entry into the inner apartment, Schopenhauer is hopeful of finding out a way through the backdoor. But he forgets that Reason is too loyal to bring about its own annihilation in this way. For what else is it if not Reason—may be bad reason—which helps Schopenhauer to dream his dream?

Schopenhauer would be at one with those who hold that the kingdom of God is within us. The key to the knowledge of the reality of things in Nature lies within ourselves. What I am directly and immediately conscious of is not my body,—for my body is as good an object as any other,—but it is my knowledge of myself as *willing* which constitutes the kernel of my being. 'Our willing', Schopenhauer observes, 'is the one opportunity which we have of understanding from within any event which exhibits itself without, consequently the one thing which is known to us *immediately*, and not, like all the rest, merely given in the idea. Here, then, lies the datum which alone is able to become the key to everything else,.....the single narrow door to the truth'⁴³. 'Will' constitutes the essence of everything in the world, from a pebble which obeys the law of gravitation to a human being who strives to rule supreme over nature's forces. 'The inner nature of everything', says Schopenhauer, 'is *will*, and I call will the thing in itself'⁴⁴. Life is everywhere the same. It is primarily and essentially a struggle. Everything in the world is ceaselessly striving to express its own innermost nature. All will is the 'will to live',

43. *Ibid.*, II, p. 405-6.

44. *Ibid.*, II, p. 407.

a blind or an unconscious impulse to exist⁴⁵. The difference between the organic and the inorganic is only a difference of degree. 'All the parts of nature correspond to each other, for it is *one* will that appears in them all, but the course of time is quite foreign to its original and only objectification, the ideas'⁴⁶. The world is will *per se*.

This is in brief the Schopenhauerian conception of the universe. Instead of the Leibnitian theory which sees in the world nothing which is not mental and thus seeks to establish the omnipresence of mind in Nature, we have here the revolutionary plan of Schopenhauer to assert the omnipresence of an omnipotent will in the world. This philosophy of the unconscious 'will', then, presents another example of the metaphysical 'unconscious', which is clerly distinguishable in kind from the one which we have in the philosophy of Leibnitz. Schopenhauer hardly leaves room to extend any further the connotation of the term 'will'.

Let us turn now to the human, which is also the more valuable, side of Schopenhauer's argument. Here, two points need especially to be kept in mind. In the first place, his conception of 'will' is too crude from the point of view of scientific psychology. It connotes, as we have seen, the unconscious instinct and the forces of inanimate nature, besides those mental processes which have the background of conscious deliberation. Secondly, it must be remembered that Schopenhauer is a thorough going pessimist and as such a typical opponent of Leibnitz. Leibnitz contended that this world is 'the most perfect actual world that is possible'⁴⁷, while Schopenhauer maintains that 'the world is.....as bad as it possibly can be if it is to continue to be at all'⁴⁸.

On this ultra-pessimistic view of the world, pain alone is positive. Pleasure or happiness is a mere delusion. Desire breeds desire; our desires and wishes are villainish by their very nature. Human life presents a sorry spectacle of a constant struggle to overcome pain and avoid misery. But this can never be achieved, for pain is nature, pleasure is only an accident and a momentary solace. Still we struggle, may be only to exist, and all our actions are just the visible manifestations of the invisible 'will to live'.

45. 'Unconsciousness is the original and natural condition of all things' (*Ibid*, I, p. 153).

46. *Ibid.*, I, p. 209. cp. 'The expression, "The World as Will and Idea" recalls the Leibnitian view of substance as essentially appetite + perception' (Latta, Introduction to the works by Leibnitz, p. 183).

47. *Principles of Nature and Grace*, § 10.

48. *The World as Will and Idea*. III, p. 396.

This 'will, as the thing in itself, constitutes the inner, true, and indestructible nature of man; in itself, however, it is unconscious'⁴⁹. It is the fountain-head of all our conscious desires and deliberate actions. Taking the analogy of 'a sheet of water of some depth', Schopenhauer observes, 'The distinctly conscious thoughts are the surface; while, on the other hand, the indistinct thoughts, the feelings, the after sensation of perceptions and of experience generally, mingled with the special disposition of our will, which is the kernel of our being, is the mass of the water..... The whole process of our thought and purpose seldom lies on the surface, that is, consists in a combination of distinctly thought judgments, although we strive against this in order that we may be able to explain our thoughts to ourselves and others. But ordinarily it is in the obscure depths of the mind that the rumination of the materials received from without takes place, through which they are worked up into thoughts..... Hence it is that we can often give no account of the origin of our deepest thoughts. They are the births of our mysterious inner life. Judgments, thoughts, purposes, rise from out that deep unexpectedly and to our own surprise..... Consciousness is the mere surface of our mind, of which, as of the earth, we do not know the inside, but only the crust'⁵⁰. It is thus that Schopenhauer tries to establish the supremacy of Will over Intellect, to show how everything conscious has its source in the 'unconscious'.

Will always strives and during its struggle expresses itself in various ways. But what is it that sets it going? In his answer to this question, Schopenhauer, remarkably enough, anticipates the present trend of the psychology of motivation as also the modern view about Instinct. 'The will of animal creatures', he writes, 'is set in motion in two different ways, either by motivation or by instinct; thus from without or from within; by an external occasion, or by an internal tendency: the former is explicable because it lies before us without, the latter is inexplicable because it is merely internal. But more closely considered the contrast between the two is not so sharp, indeed ultimately it runs back into a difference of degree. The motive also only acts under the assumption of an inner tendency, i.e., a definite quality of will which is called its *character*. The motive in each case gives to it a definite direction—individualises it for the concrete case. Being determined by mere motivation presupposes a certain width of the sphere of knowledge, and consequently a more fully developed

49. *Ibid.*, II. p. 411.

50. *Ibid.*, II, p. 327-28

intellect: therefore it is peculiar to the higher animals, quite pre-eminently, however, to man; while being determined by instinct only demands as much intellect as is necessary to apprehend the one quite specially determined motive which alone and exclusive becomes the manifestation of the instinct⁵¹. Summing up the discussion on this topic, he observes: 'Instinct and action through mere motivation, stand in certain antagonism, in consequence of which the former has its maximum in insects, and the latter in man, and the actuation of other animals lies between the two in manifold gradations according as in each the cerebral or the ganglian system is preponderantly developed'⁵². All these observations clearly show that Schopenhauer did not fail to recognise the modificatory influence of Intelligence over Instinct⁵³.

Schopenhauer's position as we have reviewed it so far comes to be this: There is first the 'irrational "will-in-general" or universal will'. The 'will' is the essence of everything in the world. The 'will to live' as manifested in human life is only a special form of this general will. The 'will' further is by its very nature unconscious, a fact which is attested to by our own experience. Consciousness is just the outward expression of an ever-striving and unconscious will, the only and necessary source of our thoughts, emotions and actions⁵⁴. Further, we are told that instinct and motivation, the two apparently distinguishable agents, control the dynamics of mind. These features of Schopenhauer's philosophy of 'will' are, from the point of view of the 'unconscious', valuable in themselves, irrespective of their pessimistic basis.

Freud himself admits that he owes the conception of Repression to a passage in *The World as Will and Idea* on madness which was

51. *Ibid.*, III, pp. 96-97.

52. *Ibid.*, III, pp. 98-99.

53. cp. Jung: 'Although individuals are widely separated by the differences in the content of their consciousness, they are closely alike in their unconscious psychology. It is significant impression for one working in practical psycho-analysis when he realises how uniform are the typical unconscious complexes. Difference first arises from individualisation. This fact gives to an essential portion of the Schopenhauer and Hartmann philosophies a deep psychologic justification' (*Psychology of the Unconscious*, London, 1921, pp. 109-10).

54. On Schopenhauer's view of the "thing-in-itself" as 'the vitality resident in the organism', Brett observes, 'in everything but its language and its excesses this view is a restatement of Aristotle's doctrine of the fundamental conation, persisting through all the scale of organic life, variously combined with and modified by corresponding degrees of conscious realisation' (*A History of Philosophy*, III, p. 82).

brought to his notice by Otto Rank⁵⁵. Direct reference to Schopenhauer's dissertation on madness would elucidate the point. In the conflict of Intellect and Will resulting in the victory of the latter, Schopenhauer finds the causal explanation of how madness breaks in upon mind. And further adds: 'If *the resistance of the will* against the apprehension of some knowledge reaches such a degree that that operation is not performed in its entirety, then certain elements or circumstances become for the intellect *completely suppressed*, because the will cannot endure the sight of them; and then for the sake of the necessary connections, the gaps that thus arise are filled up at pleasure; thus madness appears'⁵⁶. Besides being the source of the idea of Repression, we have here the origin of the Freudian constructions of the Id, the Censor, and the Super-ego, if only we modify the passage to suit the so-called normals.

The role of 'the will to reproduce' in the philosophy of Schopenhauer is as wide as it is in the Freudian theory. Sex, we are told, is the most formidable of instincts, the ultimate goal of every organism. This 'will to reproduce' influences almost all our actions. 'It is the cause of war and the end of peace; the basis of what is serious, and the aim of the jest; the inexhaustible source of wit, the key of all allusions, and the meaning of all mysterious hints'⁵⁷. Will Durant rightly detects in this observation a source of Freud's theory of the "wit and the unconscious"⁵⁸.

Lastly, I may refer to what Freud calls the *death instinct*. The end of life, Schopenhauer philosophises, is destruction, death. Now Freud separates instincts into two main groups: 'The erotic instincts, which are always trying to collect living substance into ever larger unities, and the death instincts which act against that tendency, and try to bring living matter into an inorganic condition. The co-operation and opposition of these two forces produce the phenomena of life to which death puts an end'⁵⁹. In this connection, Freud further refers to Schopenhauer: He asks 'Why should not a bold thinker have divined something that a sober and painstaking investigation of details subsequently confirms?'. But immediately he points out to the difference between his views and those of Schopenhauer: 'We do not assert that death

55. See Levine, *The Unconscious*, N. Y., 1923, p. 21.

56. *The World as Will and Idea*, III. p. 169. Italics mine.

57. *Ibid.*, I, p. 525.

58. *The Story of Philosophy*, p. 345.

59. *New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 139 (for all the citations in this paragraph).

is the only end of life ; we do not overlook the presence of life by the side of death. We recognise two fundamental instincts, and ascribe to each of them its own aim'. Naturally Freud does not wish to subscribe to the pessimism of Schopenhauer. Moreover it must be observed that to Schopenhauer human nature is but an aspect of Nature, which, in essence is 'will', while human life is almost the exclusive concern of Freud.

But with all this can we describe the 'unconscious' of Schopenhauer in strictly psycho-analytic terms? Can we ascribe to the unconscious 'will' which rules over intellect, to this 'strong blind man who carries on his shoulders the lame man who can see'⁶⁰, the character of the Freudian Id? The only answer to these and similar questions is to admit the impossibility of an unequivocal reply. For as Brett remarks, 'Schopenhauer never descended from his loftier speculations to consider the will in a scientific psychological manner'⁶¹, and, we must remember that it is his view of will which directly determines the nature of his 'unconscious'. Under these circumstances, the most we can say is that Freud is, to adopt Flugel's words, 'the scientific successor' of Schopenhauer.⁶²

(4) *Hartmann (1842-1906 A. D.).*

Hartmann dethrones the 'will' of Schopenhauer, and instead brings in 'the unconscious' to rule the universe. This alone does not make any difference beyond that of terminology, for, as we saw, Schopenhauer's 'will' too is in essence unconscious. But the real difference lies in the connotation of the term 'The Unconscious' as Hartmann uses it. With him 'will' does not remain a blind impulse groping in the dark and somehow drifting, but it is coupled with Intellect from the very beginning. The following passage makes this clear : 'I designate the united unconscious will and unconscious idea "the Unconscious". Since, however, this unity again only rests upon the identity of the unconsciously willing and unconsciously thinking subject.....the expression "the Unconscious" denotes also this identical subject of the unconscious psychical functions,—a something in the main unknown, but of which we may at least, affirm, that *besides* the *negative* attributes

60. *The World as Will and Idea*, II, p. 421.

61. *A History of Philosophy*, III, p. 82-83.

62. *An Outline of Modern Knowledge*, London, 1931, p. 357. Along with Schopenhauer, Flugel also mentions Hartmann, and adds 'we say "scientific" successor to emphasise that in his outlook he has.....been consistently more empirical than they, though the philosophical affinity between the three great thinkers is unmistakable'.

"being unconscious and exercising functions unconsciously", it possesses the essentially positive attributes "willing and representing". As long as our speculation does not transgress the limits of individuality, this may be sufficiently clear. When we, however, view the world as a whole, the expression "the Unconscious" acquires the force not only of an *abstraction* from all unconscious individual functions and subjects, but also of a *collective*, comprehending the foregoing both extensively and intensively..... All unconscious operations spring *from one same* subject, which has only its phenomenal revelation in the several individuals, so that the "Unconscious" signifies this One Absolute subject⁶³. These observations give us in outline not only the points of agreement and disagreement between the two philosophers but also the nature of the Hartmannian conception of the Unconscious from the point of view of both metaphysics and psychology.

The metaphysical unconscious of Hartmann need not detain us long. Schopenhauer contended that the world is will *per se*, Hartmann asserts that the world is 'the Unconscious' *per se*. The Will and Intellect synthesise and form a universal force called 'the Unconscious', a force from which springs the entire creation and on which rests all construction. 'The World is both 'Will and Idea'. If Schopenhauer's philosophy is to be called 'irrational', Hartmann's metaphysics may well be styled quasi-rational. The characteristics of activity and oneness are common to the metaphysical conceptions of both, but Hartmann's special contribution in 'the Unconscious' is the category of purpose. '*In the Unconscious, Will and Representation are united in inseparable unity* ; nothing can be willed which is not presented, and *nothing can be presented which is not willed*. In consciousness, on the contrary, undoubtedly also nothing can be willed which is not presented, but something may be presented without its being willed. Consciousness is the possibility of the emancipation of the intellect from the will'⁶⁴. It is this 'Unconscious' which is the ground of all things as also of consciousness. 'The world is only a continuous series of sums of peculiarly combined will-acts of the Unconscious, for it *is* only so long as it is continuously posited. Let the Unconscious cease to will the world, and this play of intersecting activities of the Unconscious ceases to be'⁶⁵. So much for the metaphysical Unconscious of Hartmann.

63. *Philosophy of the Unconscious*, London, 1893, Vol. I, pp. 4-5. References are to Coupland's translation.

64. *Ibid.*, II, p. 55.

65. *Ibid.*, p. 242.

As for the psychological unconscious or 'The Unconscious in the human mind', Hartmann himself gives a summary of his arguments on this topic as follows :

'1. The Unconscious forms and preserves the organism, repairs its inner and outer injuries, appropriately guides its movements, and mediates its employment by the conscious will.

'2. The Unconscious supplies every being in its instinct with what it needs for self-preservation, and for which its conscious thought does not suffice, e.g., man the instincts for comprehending sense-perception, for the formation of language and political institutions and many other things.

'3. The Unconscious preserves the species through sexual and maternal love, ennobles it through selection in sexual love, and conducts the human race historically steadily to the goal of its greatest possible perfection.

'4. The Unconscious often guides men in their actions by hints or feelings, where they could not help themselves by conscious thought.

'5. The Unconscious furthers the conscious process of thought by its inspirations in small as in great matters, and in mysticism guides mankind to the pre-sentiment of higher, supersensible unities⁶⁶.

'6. It makes man happy through the feeling for the beautiful and artistic production '⁶⁷.

This summary statement gives us at a glance the wide range of phenomena which is amenable to the influence of the Unconscious. Like that of Schopenhauer, Hartmann's conception too is non-empirical and therefore vague. Thought and Instinct, emotion and intuition and even reflex activity : all these are guided by the Unconscious. It is not possible to read any aspect of it in strictly Freudian terms because the very basis differs. The essential character of the Hartmannian Unconscious is not Will alone but Will + Intellect. Its whole value lies in its extra-ordinary suggestiveness.

* * * *

(b) I now proceed to take a brief notice of the views of Samuel Butler, Henri Bergson, Frederick W. H. Myers, Morton Prince, C. G. Jung and Alfred Adler.

66. cp. The subliminal theory of F.W. H. Myers below.

67. *Ibid.*, pp. 38-39. cp. James : 'Hartmann fairly boxes the compass of the universe with the principle of unconscious thought. For him there is no namable thing that does not exemplify it' (*The Principles of Psychology*, I., N. Y., 1890, p. 169).

(1) *Samuel Butler* (1835-1902 A. D.).

The phenomena of 'memory' was given great prominence by this 19th century biologist. Butler tries to explain the world on psycho-physical lines and 'memory' is the basic concept which underlies his interpretation. 'Memory' is made to explain not only the facts of heredity but even the phenomenon of evolution. Nature is full of life, there is no dead matter : this is the view of the world in which Butler finds the limiting point of the logic of his science—a conclusion which reminds us of the view of Leibnitz. And Butler contends that this all-pervading life can only be scientifically explained in terms of 'memory.' Life and memory are almost co-extensive. Behaviour in general—of a man or even that of a stone—may be looked upon as the outward manifestation of an in-dwelling unconscious memory. To illustrate these aspects of his thought, I may here refer to a few passages from his mature work, *Unconscious Memory*⁶⁸.

(i) On 'heredity' and human actions in general :

'We show that offspring has had every facility for remembering ; secondly, that it shows every appearance of having remembered ; thirdly, that no other hypothesis except memory can be brought forward, so as to account for the phenomena of instinct and heredity generally⁶⁹, which is not easily reducible to an absurdity' (p. 162).

'Our actions fall into two main classes : those which we have often repeated before by means of a regular series of subordinate actions beginning and ending at a certain tolerably well-defined point.....and actions the details of which are indeed guided by memory, but which in their general scope and purpose are new.

'At each point in any action of the first of the two kinds above referred to there is a memory (conscious or unconscious according to the less or greater number of times the action has been repeated), not only of the steps in the present and previous performances which have led up to the particular point that may be selected, *but also of the particular point itself* ; there is, therefore, at each point in a habitual performance a memory at once of like antecedents *and of a like present*' (pp. 166-67).

'As regards the second of the two classes of actions above referred to—those, namely, which are not recurrent or habitual,

68. London, 1920 ed. (first published in 1880).

69. Rivers refers to this Butlerian view of 'heredity as a species of memory' as an extended connotation of a psychological term. He himself regards heredity as 'the name we have adopted for ancestral experience' (*Instinct and the Unconscious*, Cambridge, 1920, p. 161).

and at no point of which is there a memory of a past present like the one which is present now—there will have been no accumulation of strong and well-knit memory as regards the action as a whole, but action, if taken at all, will be taken upon disjointed fragments of individual actions (our own and those of other people) pieced together with a result more or less satisfactory according to circumstances' (p. 168).

(ii) Butler's world-view :

'The only thing of which I am sure is, that the distinction between the organic and the inorganic is arbitrary ; that it is more coherent with our other ideas, and therefore more acceptable, to start with every molecule as a living thing, and then deduce death as the breaking up of an association or corporation, than to start with inanimate molecules and smuggle life into them ; and that, therefore, what we call the inorganic world must be regarded as up to a certain point living, and instinct, within certain limits, with consciousness, volition, and power of concerted action' (p. 15).

'Life is the being possessed of a memory—the life of a thing at any moment is the memories which at that moment it retains' (p. 175). To this Butler adds : 'I can conceive of no matter which is not able to remember a little, and which is not living in respect of what it can remember. I do not see how action of any kind is conceivable without the supposition that every atom retains a memory of certain antecedents' (p. 176).

One more observation is worth mentioning : 'Habit is founded on memory ; the existence of a memory is a *sine qua non* for the formation of a habit' (Butler in a letter to Walter Scott)⁷⁰.

The implications of these observations are obvious. Butler sees no gap between the organic and the inorganic. But on the strength of these he would not allow us to conclude that he is a philosopher or a metaphysician. It is the scientist's view of man and Nature founded on strictly scientific grounds. It is a conclusion which, Butler maintains, no science can avoid. Not only is there unconscious memory but there is also unconscious thought and unconscious action. Generally stated it may be said that more perfect an activity is, the more unconscious it is. For, 'Knowledge dwells upon the confines of uncertainty. When we are very certain, we do not know that we know. When we will very strongly, we do not know that we will'⁷¹.

70. H. F. Jones, *Samuel Butler, A Memoir*, Vol. I, p. 346.

71. *Unconscious Memory*, p. 20.

(2) *Henri Bergson (1859 A. D.)*

Bergson may be referred to mainly in two respects: first, his conception of *élan vital*; and secondly, his view of memory.

The concept of *élan vital* is likened, by psychologists and psycho-analysts alike, to the notion of *libido*, especially in the sense in which Jung employs it⁷². Although these two concepts cannot be taken to be exactly conterminous, both are analogous to the concept of energy in Physics. Primarily they are names for life force. Life, according to Bergson, is an *élan*, an urge. It is a continual process. Reality itself is nothing but change. And the *élan vital*, the vital and original urge, is the underlying principle which explains change in all its forms. 'It is the very stuff and reality of our being'.

Bergson's view of memory is in keeping with his main doctrine of evolution. Evolution is a process in which what we call 'present' is, evermore, being determined by the past. And *élan vital*, the original and vital thrust to which everything is subject, never allows this 'present' to rest at a particular point. The 'present' is ever changing.

This Bergsonian philosophy of the 'present' has an important bearing upon his explanation of human activity in general. He contends that the very cerebral mechanism in man is so arranged that it preserves quite in tact all our past in the form of the unconscious and admits 'beyond the threshold' 'only that which can give *useful* work'. Nobody doubts that he is carrying with him his past un-awares, though the idea about its nature and content may vary with individuals. 'What are we, in fact', Bergson asks, 'what is our *character*, if not the condensation of the history that we have lived from our birth—nay, even before our birth, since we bring with us prenatal dispositions? Doubtless, we think with only a small part of our past, but it is with our entire past, including the original bent of our soul, that we desire, will and act. Our past, then, as a whole is made manifest to us in its impulse; it is felt in the form of tendency, although a small part of it is known in the form of idea'⁷³.

72. Referring to Jung's extended use of the term 'libido' Flugel writes: 'The "libido", which in the psycho-analytic sense meant the sum total of the "component instincts" entering into the sexual urge, means in Analytical Psychology the sum total of all impulses—the equivalent of Bergson's *élan vital*' (*A Hundred Years of Psychology*, p. 197).

73. *Creative Evolution*, London, 1913 ed., pp. 5-6.

But to bring about this mutual interaction between the past and the present there must be something which links up the two, something which has the capacity not only to know the past but also to utilise it in the service of the present. This something, Bergson tells us, is 'memory'. It is our memories, 'messengers from the unconscious', which give us glimpses of what we are dragging behind us in the form of the unconscious. The following passage gives quite an adequate idea of what Bergson has to say on the rôle of memory in man; 'Our memories, at a given moment, form one solidary whole, a pyramid whose point coincides with our present,—with a present moving ceaselessly and plunging into the future. But behind the memories which crowd in upon our present occupation and are revealed by means of it, there are others, thousands and thousands of others, below and beneath the scene illuminated by consciousness. Yet, I believe our past life is there, preserved even to the minutest details; nothing is forgotten; all we have perceived, thought, willed, from the first awakening of our consciousness, persists indefinitely. But the memories which are preserved in these obscure depths are for us in the state of invisible phantoms. They aspire, perhaps to the light; they do not even try to rise to it; they know it is impossible, and that I, a living and acting being, have something else to do than occupy myself with them. But suppose that, at a given moment, I become disinterested in the present situation, in the pressing action, in both of the forces which concentrate on one single point all the activities of memory; suppose, in other words, I fall asleep: *then these repressed memories, feeling that I have set aside the obstacle, raised the trapdoor which held them back below the floor of consciousness, begin to stir.* They rise and spread abroad and perform in the night of the unconscious a wild phantasmagoric dance. They rush together to the door which has been left ajar, they all want to get through' ⁷⁴.

Besides indicating the importance of memory, the passage needs our notice in certain other respects. In his concluding remarks, Bergson very nearly approaches some of the concepts of the Freudian theory of dreams. The idea of the 'repressed memories', for instance, reminds us of the Freudian conception of Id; the terms 'the obstacle' and 'the trapdoor' easily lead us on to visualise the Censor of the Freudian psychology. But we have to

74. *Mind Energy*, London, 1920 ed., pp. 94-95. Italics mine. A part of this passage is similar—almost identical in sense, though differing slightly in the wording—to the citation from Bergson's *Dreams* quoted in the first part of this paper.

be cautious in suggesting these similarities. For, though Bergson gives us room to imagine a broad division between the conscious and the unconscious sides of the human mind, his division has nothing in common with the partition between the Ego and the Id which Freud postulates as the very soul of his theory. The similarities between the two thinkers which have been just pointed out show, on a little closer study, to be no more than apparent. The very essence of the Freudian unconscious, we know, is that it is 'active and unconscious', while the unconscious as Bergson paints it may be described as non- or extra-conscious and rather inert. Furthermore, it is good and bad in one, the dream activity being as much at the service of one part as that of the other. It is 'repressed memories' which make up the Bergsonian unconscious, while 'Instintual cathexes seeking discharge.....is all that the Id contains'⁷⁵.

(3) *F. W. H. Myers (1843-1901 A. D.).*

Myers, the poet-philosopher, has his own way of explaining the extra-conscious mental activity. He propounds a theory of the subliminal self. He is well aware that he is not the first to suggest the idea of a threshold (*limen*) or even to coin the term sub-liminal ("beneath that threshold"). They had already acquired a place in philosophical literature. But what he proposes is 'to extend the meaning of the term' (sub-liminal), so as to make it cover *all* that takes place beneath the ordinary threshold,.....outside the margin of consciousness;—not only those faint stimulations whose very faintness keeps them submerged, but much else which psychology as yet scarcely recognises; sensations, thoughts, emotions, which may be strong, definite, and independent, but which by the original constitution of our being, seldom emerge into that *supra-liminal* current of consciousness which we habitually identify with *ourselves*'⁷⁶. With this widened connotation of the term 'subliminal', Myers speaks of a subliminal self as the main spring of our ideas, emotions and actions. What needs to be noted, as an important difference between Myers and Freud, is that the subliminal self is not discontinuous with or antagonistic to the supraliminal self. Myers does not believe in parallel selves absolutely independent of or opposed to each other. They may be quasi-independent but there is between them enough co-operation and continuity to impart to the mental life of the individual the all-important character of oneness. He goes so far as to bring the mental activity of the

75. Freud, *New Introductory Lectures*, p. 100.

76. Myers, *Human Personality and its Survival of Bodily Death*, New 2nd. impr., London, 1927, pp. 14-15.

normal and the average in a line with that of a genius. He writes: 'I claim that man shall be regarded as normal, who has the fullest grasp of faculties which inhere in the whole race. Among these faculties I count subliminal as well as supraliminal powers ;..... and I attempt to show that those who reap most advantage from this submerged mentation are men of genius'⁷⁷. It is interesting to note in this connection that Myers refers to 'the monitions of the Daemon of Socrates' as the 'precognitive information' supplied by the subliminal self of a man of transcendent genius'⁷⁸. Myers further conceives the possibility of a world of spirits with which the subliminal or the unconscious, rather than the conscious, self is capable of being in closer and more direct communication. This fact again points to a very significant difference between him and Freud.

(4) *Morton Prince (1854-1929 A. D.).*

Morton Prince is an instinctivist who tried to grapple the problem of the unconscious on certain new lines. We cannot refer here to all the different aspects of his views. Change in the current terminology—which Prince regards as an improvement—is one of his important contributions to the psychology of the unconscious. It is mainly with this change and its meaning that I will concern myself in the sequel.

'I.....use the term subconscious', says Prince, 'in a generic sense to include (a) *coconscious ideas or processes* ; (b) *unconscious neurograms* ; and (c) *unconscious processes*'. Accordingly, we get from him the following classification of 'conceptual facts'. Whatever is non-conscious or extra-conscious is called the "Subconscious" which comprises "the Coconscious (Synonym : subconscious ideas)" and "the Unconscious", i. e., '(a: Conserved dormant neurograms or neural dispositions. b: Active functioning neurograms or neural processes. Synonym: Unconscious processes)'⁷⁹. The unconscious, in other words, is physical or neural in character, while the coconscious is psychological or ideational. Functionally, the latter is more close and more easily accessible to the introspective consciousness than the former. The term coconscious, as Prince uses it, has reference not only to double or multiple personalities but also to a normal personality. It is, however, the former which enable Prince to substantiate his main hypothesis. For, it is to be remembered that Prince is, besides being an instinctivist, a champion

77. *Ibid.*, p. 15. These words stand good comparison with Montmasson's observations on invention and the true inventor cited above p. 110.

78. *Ibid.*, p. 65.

79. *The Unconscious*, London, 1924. p. 253.

of purposivism ; and cases of dissociation, he utilises as his chief data to show the psychological significance of the conflict that takes place between the different purposive systems which belong to different personalities representing, as they do, several sharply divided sides of the psychic life of an individual. This conflict is not absent in a normal personality. It is there but is capable of being integrated into one purposive system, i.e., it is not so very abnormal as to fissure the personality into parts which refuses to fuse into one psychic whole. Prince thus tries to show that the difference between the normal and the abnormal, though quite fundamental, is after all a difference of degree. He is a psychic monist and his psychology of the unconscious hinges on the principle of teleological causation.

(5) '*C. G. Jung (1875 A. D.-)*).

Jung and Adler are perhaps the most important of Freud's dissenters. It was a decade or so after the institution of the psycho-analytic school that these two lieutenants of Freud found that the disparity between their views and those of their master was of so serious a nature that mutual co-operation on the basis of intellectual honesty and for the purposes of scientific advance in the understanding of human mind was no more possible. But in between themselves, they agreed only on the point of dissociating from their master, for, individually, they had their own differences. The result was that each founded a school of his own : Jung led the sect of Analytical Psychology, Adler that of Individual Psychology.

At this stage in the development of Psycho-Analysis, it is very difficult to say as to which of these three chief schools is on the right track. Each displays on the part of its leader that admirable spirit which is so very essential to push ahead the boundaries of human knowledge. Like all beginnings, each has sufficient merits to justify its own existence, and also enough drawbacks to allow the continuance of others.

It is mainly on the question of 'pansexuality' that Jung differs from Freud. Freud restricted the term 'libido',—until, at any rate, he and Jung parted their ways,—to connote almost exclusively 'sex-energy'. He had gone so far as to contend—and one can hardly see any radical change in his views in this respect even to this date—that Life is not only predominantly determined by sex but that it is entirely so. Jung thought that it was absolutely necessary to extend the meaning of this term. He describes his standpoint as genetic and distinguishes it from the descriptive. This genetic standpoint 'regards the multiplicity of

instincts as issuing from a relative unity, the primal libido; it recognises that definite amounts of the primal libido are split off, as it were, associated with newly formed functions and finally merged in them. As a result of this it is impossible from the genetic standpoint, to hold to the strictly limited conception of libido of the descriptive standpoint; it leads inevitably to a broadening of the conception'⁸⁰. The extent to which Jung has widened this conception may well be grasped from the fact that it has to be placed, as we have already seen, side by side with Bergson's *élan vital*. Hinkle, in his introduction to Jung's *Psychology of the Unconscious*, brings out this point very clearly. He writes: 'He' (Jung) 'saw in the term libido a concept of unknown nature, comparable to Bergson's *élan vital*, a hypothetical energy of life, which occupies itself not only in sexuality but in various physiological and psychological manifestations such as growth, development, hunger, and all the human activities and interests. This cosmic energy or urge manifested in the human being he calls libido and compares it with the energy of physics'⁸¹.

Naturally this reformed notion of libido had a corresponding effect on the conception of the Unconscious. The Unconscious is characterised by two factors in the main: (a) the repressed complexes which have reference, so far as is possible, only to the life and experiences of the individual concerned: the "Personal Unconscious"; and (b) the inborn tendencies, the "archetypes"⁸² (which are comparable to instincts): the racial or the "Collective Unconscious". Thus the Unconscious as conceived by Jung comprises much more than the Id of Freud: like Bergson's it is a vast storehouse which contains not only the bad but also the good. We need not here speculate to ascertain the depth of the Freud-Jung differences, for Jung himself has justly observed: 'The contrast between Freud and myself goes back to essential differences in our basic assumptions'⁸³.

(6) *Alfred Adler (1870 A. D.-)*

Adler gives prominence to the instinct of self-assertion or (to use McDougall's phrase) the self-regarding tendencies and relegates sex-instincts to a secondary status. Like Nietzsche's philosophy of the

80. Jung, *Psychology of the Unconscious*, trans., London, 1921, p. 83.

81. *Ibid.* p. xvii.

82. These result in accordance with the Lamarckian theory of inheritance. Mythology and folk-lore furnish valuable data in respect of these "archetypes".

83. *Modern Man in search of A Soul*, Trans., London, 1933, p. 142.

superman, Adler advocates the cause of the psychology of the will to power. That human life, from the cradle to the grave, is full of conflicts, Adler accepts along with Freud and Jung. But his explanation of this phenomenon of mental conflict which is responsible for the shame and glory alike of mankind differs from either. Man, by nature, is defective in one way or another, and strives all his life, after perfection, perfection which he is hardly able to achieve. He is thus destined to labour, from day to day, under a sense of inferiority. He is never free from the pangs of this "inferiority complex". He tries to get over his defect (or defects) in more than one way: by attempting to overcome it, by establishing his worth and superiority in some other sphere, or by endeavouring to escape the claims upon him of his surroundings through the agency of some externals like mental disease. It is in this way that Adler looks upon abnormal disorders as so many attempts at psychic compensation for defects which are bodily or mental or both. The other ways of substituting superiority for inferiority represent the different devices employed by the normal minds. Thus in the psychology of Adler egoistic supremacy comes to acquire the all-powerful position of the primary motivating force. It is this craving that lies at the basis of "the unity of the personality". Adler observes: 'As Kant has said, we can never understand a person if we do not presuppose his unity. Individual psychology can now add to that: this unity, which we must presuppose, is the work of the individual, which must always continue in the way it once found towards victory'⁸⁴.

GENERAL CONSIDERATIONS

We have, in this section, traced the development of the ideas about the unconscious from Leibnitz to Adler. On the basis of chronology, their ideas may be classified under two heads: the ideas which are evolved independently of Psycho-Analysis may be distinguished from those which cannot definitely be said to have been evolved in this way. The views of Leibnitz, Herbart, Schopenhauer, Hartmann, and even those of Samuel Butler would go under the former category. The ideas of the rest, on the other hand, show clear traces of the influence of the psycho-analytic wave. To ascertain, however, the exact nature and extent of this influence with regard to the individual contribution of the thinkers concerned a more intimate knowledge of the psycho-analytic and the contemporaneous literature than what I can claim to possess is necessary. My attempt here has been only to describe succinctly their individual points of view for what they may be worth.

84. *Psychologies of 1930*, ed. by Murchison, London, 1930, p. 399.⁶

Leibnitz was undoubtedly the first, not only among the moderns but in the whole history which we have traced, to recognise the psychological significance of the unconscious side of our mind. Next to Leibnitz, in order of importance, may be named Schopenhauer, to be followed by Herbart and Hartmann. Samuel Butler, who stands by himself in his point of view, would come next.

Bergson cannot be said to be entirely free from the influence of the psycho-analytic atmosphere. Certain points in his philosophy of memory display quite a perceptible bearing of the psycho-analytic ideas on the line of his argument. But his notion of the unconscious is essentially philosophic and as such non-psycho-analytic. The conclusions of Myers, who follows Bergson, are deductions based on extensive and quite reliable data, but the interpretation is his own which is mainly determined by a unitary point of view. Morton Prince is a contemporary of Freud: Jung and Adler were once his disciples. Naturally their ideas form a part of the New Psychology.

III. UNCONSCIOUS OF THE NEW PSYCHOLOGY.

Criticism of Psycho-Analysis does not form a part of our aim. The sketch of the psycho-analytic theory, its basic principles and fundamental conceptions, has been already presented in the first part of this paper. The purpose of this section accordingly is just to render the account complete in itself by supplying an internal coherency with the least possible repetition.

(a) *Its Theoretical Aspects.*

Psychological literature is being flooded with expositions, faithful or otherwise, and criticisms, impartial as well as biased, of psycho-analytic work. Though it is scientifically rash to hazard the statement that all the implications of a new movement are exhausted within less than half a century by the numerical strength of its expositions and criticisms, there is no risk if I say that to-day not much of the merits and demerits of the New Psychology remains to be known. Science would be wasting its priceless energy if it tries, so far as the present state of Psycho-Analysis is concerned, to mend the structure without resetting the foundation. The very method of approach must be changed. Complete overhaul is the immediate and peremptory need. There is no danger of any waste if the extensive material at our disposal to-day is carefully sifted and properly channelised with a suitable scientific perspective. I do not mean to suggest that the labours of Freud and others have been wasted. Not in the least. Waywardness and lack of method have

characterised the first ventures of even those sciences which are now counted among the most systematic. The very concept of method and a point of view presuppose at least some knowledge of the nature of the data to be handled. And so far as the latter is wanting, the former cannot be expected. But the tenure of this preliminary stage is not limitless.

'Change' appears to be the watchword of Freudianism. Inconstancy may render helpful service in making things work, but for theoretical advance in any branch of knowledge it is definitely harmful. Recklessness at changing notions breeds indifference and irresponsibility about the relatively permanent good of the cause of one's devotion. As it is, however, let us try to understand here the nature of what lies at the basis of these Freudian changes.

Causeless phenomena do not exist; human nature in all its variety is just a play of certain permanent instincts, or call them desires,—the variety being due to the environment in which it is presented; and the mind is dual: these are what seem to be the centripetal forces which direct and control the logic of Freudian interpretation of psychological phenomena.

The validity and efficacy of the first proposition, no science can doubt. But what spoils the matter is the peculiar attitude of Freud. He fails to be scientific in the causal explanation of the data before him. On the one hand, he shows a passionate patronage for the principle of 'trial and error'; on the other, a surprising lack of the 'give and take' policy. His attitude is that of a parson towards the wording of the Holy Scriptures—an attitude to which no genuine scientist can subscribe. Religion *qua* Religion can never be Metaphysics, only because the prophets preach at their highest that Metaphysics is nothing but Religion: and dogmatism cannot help Freudianism to survive long, if it is to fuse with the science of psychology. A stage has reached since long for drastic modifications.

The second proposition I might illustrate with the help of Freud's famous hypothesis of the Œdipus complex, which exemplifies Freud's dogmatic attitude also. As the main source of our sexual instincts primarily, and also as an important argument for heredity, this hypothesis forms a foundation stone of Freud's theory⁸⁵. This complex is supposed to explain several things—the origin of the abnormal mental phenomena, the genesis of religion, morality, social customs etc., facts of mental inheritance, and even

85. Mr. M. M. Desai in his paper on *The Origin of the Horror of Incest and of Œdipus complex* has conclusively proved the scientific unsoundness of this hypothesis. See July (1933) issue of this Journal. •

the shaping of the normal mind. The implications of this complex as laid bare by Freud himself are such that one who accepts this hypothesis of the Œdipus complex automatically vindicates his implicit faith in the theory of group mind⁸⁶, as also the Lamarckian theory of transmission of acquired characters—theories which are now quite famous for their extremely doubtful footing. Under these circumstances, to subject the highly imaginative suggestion of the universal prevalence of this complex to an independent scrutiny is to flog a dead horse for the *n*th time.

The idea of the 'super-ego' is no less baffling. The 'super-ego' is a supergrowth of the Œdipus complex. 'Conscience', we are told, springs directly from the Œdipus complex; and the 'super-ego', the most recent of Freudian wonders, may be described as the conscience-in-chief. The 'super-ego' is that part of the Unconscious which somehow escapes by a sidetrack and manages to lodge itself in such a position of vantage that it can keep a strict watch on the doings of the ego and pounce upon it whenever necessary.

I can understand this conception of the super-ego in no other way but as a makeshift device to explain the working of the normal mind with the help of the deductions drawn from the data supplied by the abnormal phenomena—a tendency which vitiates Freudian attempts at interpreting normal behaviour and working of the average mind in other respects also. The logic by which Freud builds up the other important pillar to support his structure, viz., the dualistic conception of mind, fails to explain satisfactorily the idea of the super-ego. Freud seems now to imagine two ways which may link up the conscious, i.e., non-unconscious, and the Unconscious: one is the psycho-analyst himself, the other this super-ego. This innovation, if it does anything, leaves the confusion worse confounded. The nature of this confusion may well be grasped from one of Freud's pregnant observations: 'When the ego is forced to acknowledge its weakness, it breaks out into anxiety; reality anxiety in face of the external world, moral anxiety in face of the super-ego, and neurotic anxiety in face of the strength of the passions of the soul'⁸⁷. I do not find my way to understand 'reality-anxiety' in contradistinction from 'moral anxiety' and both these from 'neurotic anxiety', as mutually exclusive. A compartmental description such as Freud gives us

86. It is to be noted that even McDougall, the father of this theory, seriously questions the scientific legitimacy of hypothesising Œdipus complex. See his *An outline of Abnormal Psychology*, London, 1926, pp. 417-21.

87. *New Introductory Lectures on Psycho-Analysis*, London, 1933, p. 104.

here distorts the importance of mental facts and their psychological significance. Freud would perhaps contend that his exposition is popular and his claims modest. But would he at the same time say that he is not trying to make Psycho-Analysis part and parcel of the science of psychology? It is to these popular expositions—and much of Freudian literature is of this type—that are to be traced the inconsistencies that cloud the methods, results, and aims of the New Psychology, inconsistencies which scare away the theoretically minded from taking adequate interest in the discoveries of this highly important branch of knowledge.

An extensive gulf separates the normal mind from the abnormal one, and it is scientifically risky to rush to generalise about the former with the help of the evidence supplied by the latter. One may very well imagine the peculiar pleasure which a successful man derives, when standing on the terrace of his villa, he exclaims in a pathetic-frenzy: 'Oh, suffering friend! Don't think that I am inhuman. You are in no way less than a brother to me. Put on a stubborn fight, for you well know that the doings of Providence are beyond our control!' Freudian endeavour to see normality in the abnormal minds, and abnormality in the normal ones—that is, to bring the one in line with the other—differs in no way from the attempt of our villalord at establishment of universal brotherhood. If the Freudian conception of mind, as sharply divided between the ego and the id, which seems workable as regards the abnormal minds holds equally good about the working of the normal minds also, the process of sublimation becomes meaningless and loses all its theoretical value. To control and overcome what are called complexes, for instance, is quite possible, though rather a difficult achievement for a well developed mind; but this is a feat beyond the capacity of the abnormal natures,—abnormality being an index to a particular kind of weakness. All these enigmas are mainly due to the fact, rightly pointed out by McDougall, that 'Freud has approached psychology from the medical point of view, ignoring almost completely the works of other psychologists. And, except in some of his writings of recent years, in which he has taken into consideration some of the wider anthropological problems, he has built upon such knowledge of human nature as he has from the intensive study of his patients' ⁸⁸.

(b) *Its Practical Aspects.*

Once we admit that Freudianism is significant not so much for its findings, but for its far reaching implications and weighty suggestions, its value is immensely enhanced. It is beyond doubt

88. *An Outline of Abnormal Psychology*, London, 1926, p. 157. '.

that we are not so much troubled over wars that are fought outside us as by those which are always raging and surging within us. It is Psycho-Analysis that opened our eyes to the fact that these invisible wars are not chance wars, that mental conflicts are not causeless, that Mr. X's dislike for a particular person or his inexplicable tendency to avoid a particular situation is not very different, so far as the law of causation goes, from the tendency of the stone to obey the law of gravitation. The imperceptible influences which mould the child sow also the seeds of our adult behaviour and what goes by the name of 'character'. Freud has been trying his best to prove conclusively that child is the father of the man is not a figment of poet's imagination but a hard psychological fact. The proper education of the child holds the key to secure an all-round development of the individual which in its turn helps to form a healthy society. We are to-day struck at every corner of our economic struggle by what is known as the population problem, that wild cry for conditions favourable to get an optimum population, the problem of right and moderate breeding. At such a juncture, we owe it to Psycho-Analysis that it has helped us to realise the seriousness of the necessity of grappling the problem of training which is no less important than the problem of breeding. The urgent concern of the social psychology at present is to catch hold of means and ways conducive to the harmonious development of our emotional life primarily, to help the cultivation of proper attitudes and healthy tendencies in face of actual and possible situations. Herein we have also the arch-problem of the motivational and conational psychology which was pushed to the front in an emphatic way only when Psycho-Analysis entered and explored the field of psychopathology. Whatever may be the drawbacks and shocks which Psychology has received from explorers in this field, to question the stimulative influence of their trials and errors is a dogmatism of the type which surpasses even that displayed by Freud in upholding the dignity of even the most immature of his findings.

RETROSPECT.

We may now summarise the results of our discussion.

(i) The recognition of the fact that the chief determinant of the working of human mind is not consciousness but something which lies beyond its perceptible reach goes back to the beginnings of philosophical thought. But our knowledge of this recognition by the ancient thinkers is mostly inferential. It is Leibnitz who recognised, for the first time, the significance of the Unconscious as the guide and controller of the conscious mental activity and of behaviour in general.

(ii) History shows a gradual development of this notion of the 'unconscious', and authenticates the fact that the concern shown by thinkers towards the influence of the unconscious mental activity in general is becoming more and more intense. As regards the development, however, it cannot be maintained that it has been, all through, along one and the same line. Fixity is lacking even when we are supposed to be far more scientific in our attitude and still more rich in our systematic equipment than the ancients. Psycho-Analysis itself, which had to branch off, just within a period of about a dozen years, into three different lines, illustrates the point in question.

(iii) The distinction between the philosophical or metaphysical and the psychological unconscious has been found to be fairly workable for tracing the history of the concept of the unconscious. To refer, however, to the two types as mutually exclusive would not be correct, because, as we saw, either of them is the extension of the other wherever we have come across two together as aspects of a system propounded by one philosopher. And this also implies that there is no overlapping of the two concepts. Their respective universes of discourse render them sufficiently distinguishable.

(iv) There is a sharp distinction between the psycho-analytic conception of the unconscious and that of the classical or even that of the modern psychology. Freud's dualistic conception of mind and the figurative categories which clothe it are not very easy to understand. The unique contribution of Freud, however, consists in shifting the very centre of psychological investigations, in lifting Psychology from the position of a baseless dome of intellectualistic categories to that of a science of life, in showing Psychology the way *to be* Psychology.

G. K. SABNIS

THE STUDY OF INDIAN PHILOSOPHY

The following article is written on the assumption that 'all is not well' with the study of Indian Philosophy in our universities and elsewhere. The assumption, I have no doubt, will be questioned by many. I shall therefore preface the present discussion with a short statement in defence and explanation of my assumption.

It seems to me, that there is ultimately only one test of the calibre of any study—namely that it makes its subject-matter live in the minds of men. And whenever men have taken an active and living interest in a subject they have invariably been progressive and creative in that sphere. Judged by this test, it is easy to see that the study of Indian Philosophy has not succeeded. It is now more than fifty years since Max Muller and others led the way and they have had a brilliant galaxy of successors in Europe and India. Even so, the subject continues to be what it was then—a department almost exclusively of historical research. In a survey of the world's present-day philosophical activity it may be safely neglected. As studied at present Indian thought shows no signs of growth, vitality or initiative. It seems to have no message—nothing to say about—to the world in which we live.

The worst aspect of the situation is our failure to notice the deadlock to which we have arrived. We are quite satisfied with a reconstruction or interpretation of ancient Indian speculation and do not ask ourselves or answer the question how the subject of our study would react to all the complex puzzles which the march of civilization has thrown up during its course. This habit of treating systems of thought like specimens in a museum has blinded us to the fact that speculative systems like everything else die away in unnatural conditions and that unless we restore the ancient thought of India to its natural home—a thinking mind—even the specimens will soon disappear. In fact, the process of decay has already started and many a serious student of philosophy turns away from the subject as a mere jugglery of words.

There have indeed been a few exceptions. In particular, some of our literary men and several idealists in the province of religion and morality have realised that in the spiritual world one cannot possess a thing without helping it to live and grow. As a result, they have, within their limits, made a not inconsiderable contribution to the growth and therefore to the true study of early Indian

thought. For obvious reasons, however, their contribution to the study of Indian philosophy as such, is of a somewhat indirect and uncertain character. With regard at any rate to a very great part of modern literature on Indian philosophy proper, even this cannot be said with truth. On the other hand, it is impossible to imagine that the visions of the Upanishadic seers and the great systems of the Acharyas are so 'out of joint' with the realities of life as their modern interpreters would have us believe. My suggestion is that there has been a serious error in our approach to these early systems of thought. It is the purpose of this article to deal with what seem to me to be the principal sources of this error.

It would appear that two somewhat contradictory notions have continually obsessed us in our study of Indian philosophy and both of them have been injurious to the proper appreciation and treatment of the subject. The first and commoner one would insist on attaching to philosophical terms and methods a significance which belongs to religion, morality or some other part of practical experience. Thus we are told that in India Philosophy has never been a matter of the intellect only, that the Indian approached philosophy for salvation and not for mere truth. It is argued that the goal of philosophy with us has been more concrete, practical and human than in the West and that practical discipline or faith or Sruti or all of these are considered by our thinkers to be legitimate supplements of logic, in the search of philosophical reality.

This position may for convenience of treatment be divided into two parts. In the first place, it consists in an assertion that the goal of Indian philosophy unlike that of Western philosophy is not mere truth-search but that it includes truth-search and supplements it by certain other requirements of human nature. The goal of Indian philosophy being thus more than intellectual it needs and justifies the acceptance of an extra-intellectual method. In the second place, it is maintained that even independently of the nature of the goal, the Indian thinkers both positively and negatively express their dissatisfaction with logic and intellect and adopt some other method to supplement these.

In one form or another this notion has been invariably present in the minds of most who in recent times have made Indian philosophy the subject of their work and study; and in all its forms it reveals a total misunderstanding of the task and method of philosophy as conceived by our own as well as European thinkers. No serious thinker in the West has ever sought an abstraction as the goal of his philosophy. Repeated avowals on the point from the time of the Greek thinkers to our own times leave no room for such

a supposition. Indeed, the very birth of European philosophy is due to the dissatisfaction felt at the abstract realities vouchsafed by science and 'opinion'. The fact that philosophy seeks concrete reality is so well accepted in the West that every exponent of a new method in philosophy has always sought to prove how his method (e. g. Intuition) and not any other leads to concrete reality and how therefore it is the most acceptable method of philosophy.

On the other hand, as Stace and others have pointed out, the attempt to make the goal of philosophy practical and human in any special sense without impairing its philosophical character is doomed to failure. Unknown to themselves, these students of Indian philosophy make the goal of their study just what they so emphatically declare it is not—namely abstract. They believe, indeed, that they are only adding to the logical ideal certain characteristics needed by other aspects of our nature. The addition however cannot be made for the simple reason that the characteristics rebel against each other. Briefly, it is futile to make the philosophical goal anything except or in addition to itself. Those who in their mistaken zeal make this claim on behalf of Indian philosophy do not know what they ask for. It is to them that we owe the judgment passed by several historians of philosophy in the West that the so-called Indian philosophy is at its best religion, ethics, poetry but never philosophy proper. It is impossible to contest this verdict successfully if we admit that anything except logic or reason is accepted by Indian thinkers as sufficient or relevant in the valuation of a philosophical theory.

It does not however seem necessary or even proper to make any such admission. Apart from the term salvation which by itself is of too vague a character, the two other terms occurring invariably in connection with the description of the goal of philosophy in India are happiness and cessation of misery. These terms do undoubtedly stand for something practical in their common use. A careful consideration of their use by the Indian thinkers will however always reveal the fact that they are here used to express something different from the practical states usually signified by them. In fact, the Indian thinkers show great anxiety to signify the special use of these terms. Descriptive epithets like 'eternal', 'non-sensuous', 'non-mental' and others hardly consistent with happiness as we ordinarily understand it, are invariably used and emphasized in connection with happiness which we seek as the goal of philosophy. Similarly the whole of mundane existence is included in the three-fold misery from which it is the task of philosophy to save us.

To any one who thinks about the matter it is clear that the search is for something different from happiness and cessation of misery as we know them in daily life. The notion of a happiness which is eternal, non-sensuous and non-mental is certainly not our usual notion of happiness. Again, a person who turns his back on the whole of mundane existence as full of misery must surely mean more by it than disease, poverty or dishonour. To escape from these one need not go beyond life—in fact one must not do so, for honour, wealth and health belong to life as well. None of these however satisfy the philosopher. Looking at it either from the point of view of the happiness which he seeks or the misery which he seeks to avoid, we cannot help feeling that what he has in mind is something more fundamental, lasting and universal than the practical states of pleasure and pain. Nor does the Indian philosopher leave us without a clue as to his meaning. He tells us that the only method of securing what he desires is true knowledge. There is difference of opinion among Indian thinkers as to what constitutes true knowledge but never as to its being the only pathway to the goal of philosophy. True knowledge however is, as we all know, the specific cure for ignorance. Thus if we consider the terms happiness and cessation of misery with proper reference to their context we come to the conclusion that they do not stand for the emotional states usually signified by these terms but stand rather for a state of perfect knowledge overcoming all the manifold ignorance of the finite mind. Of course the search and acquisition of truth and the conquest of ignorance and falsehood are practical activities in a sense. But these admittedly constitute the goal of European philosophy as well and will not serve as distinguishing marks of Indian philosophy.

At this stage, we pass on to the second part of the position under consideration. By reference to actual statements of the philosophical method by Indian thinkers, it is pointed out that these include what must necessarily be called 'practical discipline' of various kinds. The importance of the discipline in the philosophical method is emphasized by reference to the fact that it constitutes something like the test of eligibility for the role of a philosopher. Once again, however, and without controverting the statement of facts as made above it may be seen by anyone who cares to give deeper thought to the matter that the discipline is at best a condition precedent but never a part of the philosophical method. By itself it never takes us anywhere near the goal of philosophy.

We are then referred to the statements which prescribe physical, mental and moral discipline when the intellectual procedure has run out its full course and arrived at its results. We

are told that in order to 'realise' what is merely 'understood' by the intellect it is necessary to undergo certain bodily and mental discipline. The reply consists in pointing out that although the discipline is preached in connection with the philosophical method, it is no part of it nor is it a real supplementation of same. Just as at the start so at the end, the Indian philosopher mentions what in his state of scientific knowledge seems to him a useful practical rule in order that the human being constituted as he is, may easily and securely possess the knowledge which alone leads him to salvation. The true test is to ascertain whether the so-called realization is richer in content than understanding. The answer to this question must, in spite of certain apparently contrary statements, be in the negative.

On this question of method, reliance is also placed on statements in Indian philosophy asserting the inadequacy of the intellect as a method of philosophy. We have however only to study these criticisms of the intellect to realize that they are not inconsistent with the fullest use of and faith in intellect. In one word, they are criticisms of intellect by itself and are themselves a proof of the validity and adequacy of the intellectual method.

I cannot help feeling that my arguments specially on the question of method must seem dogmatic to many. All I can say in reply is that they are not so and I hope I have given enough material in my remarks to suggest the lines proceeding on which I have arrived at the conclusions mentioned above. Before proceeding to the other notion which to my mind, along with the first, has fundamentally vitiated the modern study of Indian philosophy, I shall briefly recapitulate the conclusions which I have so far been upholding.

Indian philosophy is no more practical than Western philosophy. Its method like that of the Western philosophy is intellect and logic. The western philosophy is not abstract in any special sense. The attempt to make Indian thought concrete by adding practical characteristics to the logical goal fails utterly and, if possible, makes it more abstract than before and renders it unphilosophical. There are undoubtedly statements in Indian Systems of philosophy both with regard to the goal and method which may mislead one into believing that Indian thought is more practical than European; nevertheless having regard to the entire context they can and ought to be understood differently. It is possible to hold that the goal and method of philosophy which I believe is identical in the East and West is abstract and unsatisfactory compared to the method and goal of religion.

or higher art. So far as this article is concerned, I leave the question open.

The other notion which has dominated us in our study of Indian philosophy is borrowed from many other modern studies and encourages the use of what is called 'the comparative method'. The comparative method is undoubtedly a valuable method. It is based on two important aspects of human experience—the central and innermost unity of knowledge and the diversity of circumstances. It is unnecessary to acknowledge how in various fields of experience it has led to very interesting and useful results. Its success first in the field of natural science and later in certain provinces of mental sciences has naturally created a growing faith as to its efficacy and it is no wonder that the modern students of Indian philosophy felt greatly attracted by it. If we keep in mind the confusion and almost the deadlock which resulted in the study of Indian philosophy owing to the notion we considered above, we may very easily understand how the comparative method must have appeared as just the thing to set matters aright. Indian philosophy, it was seen, could not be supposed to possess any peculiar method or goal. What more natural then than to assume that it and the European were parallel currents of the self-same philosophy? And the use of the comparative method with its great and deserved prestige would naturally appear under the circumstances to be the proper method of checking and confirming the assumption. I do not suggest that the acceptance of the comparative method was always or certainly due to the desire to escape from the error considered above. In all probability, both notions were entertained independently and sometimes by the same thinkers without realising their exact relation. In fact it has often seemed to me that the comparative method has been adopted and preached just by those who have announced the 'peculiarity' of Indian philosophy. In this case obviously it is more in the nature of an expiation than a correction of the first standpoint!

Whatever the reasons however, it is clear enough that the comparative method has not succeeded in getting the study of Indian philosophy out of the morass. On the other hand, I believe it has made its own contribution of mistakes to a study already brimful of them. And the reason it seems is that the method can be properly used only at a certain stage of knowledge in a subject and prematurely used is apt to lead to grave errors. It presupposes an independent general acquaintance with both terms of comparison and on that basis is useful for a complete understanding of the various stages of growth or change in either study. In the present case, however, such acquaintance was absent and writers

starting with the idea of comparing certain doctrines in Indian philosophy with certain others have done nothing short of identifying them.

And by the nature of the case the less-known system suffered in the process. The less-known, it need not be said, was the Indian system and all that happened at the end was that the Indian thought was seen to be an excellent illustration of the 'curious' garb which the philosophical doctrines of the European could take under different circumstances. Shankar's *Vyavaharik Shrishti*, it was felt, could be very well compared to Kant's *World of Phenomena* or Bradley's *Appearances*. There is undoubtedly some justification for the comparison but in order that the comparison may be philosophically significant it is necessary that the terms of comparison should remain distinct till the end. What happens however in this and in almost all other attempted comparisons of Indian with European doctrines of thought is that the Indian doctrine is gradually shifted further and further into the background till at last it is almost unrecognizable. Its existence seems on the showing of most of these modern thinkers to have had only one justification—namely to serve as additional instances of doctrines known in the West. All that suggests difference is explained away partly as the result of India's peculiar social and religious tradition and partly to the difference in the scientific outlook of the times. The fact that Indian philosophy must not be supposed to have any 'peculiarities' seems from this point of view to have been learned almost too well!

There is reason to hold that just as in the first case, so here our scholars have been doing things with a full consciousness of their actions. Right from the time of Max Muller every one of them has invariably announced that he will interpret Indian thought in terms of European speculation and thus help the reader to understand the less familiar by analogy with the familiar. An analogy, however, cannot be a safe guide until we are aware of the difference as well as the similarity between the terms of analogy. In the present instance there is no knowledge about the difference—a wholesale and mistaken identification follows with no real addition to our information in either system of philosophy. The truth of the matter is that the time has not yet arrived when one may properly make use of the comparative method in the study of Indian philosophy. We do not as yet know enough about the foundations of early Indian thought to be able to compare its products with those of European philosophy. We must for the time being fall back on ourselves and carry on our observation and analysis of Indian thought until we are able to ascertain the essential structure of the Indian systems of philosophy. It is only at that stage that

the comparative method rightly steps in and by comparing and contrasting products of two systems of thought helps to a better understanding of both.

The suggestion regarding 'falling back on ourselves' perhaps needs some explanation. I do not suggest that the modern student of Indian philosophy should forget his privileges and responsibilities as a product of the twentieth century. Far from it. Let him bring to his study all that he has absorbed and made his own from the vast store of scientific and philosophic experience of his times. All that is required of him is that he should apply his mind so enriched, to the understanding of what is actually presented to him in the various systems of early Indian thought and refrain from 'interpreting' an idea before he has 'understood' it.

Indeed, it seems to me that the comparative method itself may have some use for us if it is accepted with a certain modification. We should try with its help to interpret European thought in terms of Indian thought instead of interpreting Indian thought in terms of European. This would enable us to use all the wealth of experience which Europe has collected during the last two thousand years without impairing the formal outline of our own thought-systems. It will then be a case of a 'genuine lifting up'. Indian thought will then become up-to-date without ceasing to be itself. The effort to make room for the content of European thought within the frame-work of our own thought will help the latter grow and will entail no mutilation of either the content or the form.

At present we start with the assumption that there could be nothing in the West which did not at sometime exist in the East, and try to forget for the benefit of the East what the West has since learnt. The result is complete ignorance of the first and an incomplete knowledge of the second. What precisely I have in mind by the modification I suggest in the use of the comparative method may be made clear by reference to the case I mentioned above. Shankar's Vyavaharic Shrishti and Kant's World of Phenomena or Bradley's appearances have undoubtedly something in common. On the basis of this resemblance we usually try to assimilate Shankar's doctrine to either of the latter—and to explain away any differences by reference to the general course of historical and cultural changes since Shankar's time. The result is we have at best known the Bradleyian or the Kantian doctrine in yet another form from what they took in the West. Of Shankar's distinctive contribution to the growth of speculation we know nothing. Instead, let us take our stand in Shankar's doctrine—probe ever deeper into it, understand its full implications in Shankar's system

and then ask ourselves how the doctrine could be restated to accommodate all the wonderful growth of science and logic which Kant and Bradley inherited. Here we are never made to forsake anything that is distinctive in Shankar's doctrine ; on the other hand, nothing that Kant or Bradley are in a position to contribute, is ignored.

It may be easily seen that the two errors we have considered so far are dogmatic in character and that to avoid them is merely to take up an unprejudiced commonsense standpoint. We do not suppose that Indian philosophy is anything so peculiar and individual as to have its motive or general method entirely different from those of western philosophy. Nor do we assume that our philosophic ideas and theories must be identical with those of the West. When we come to think of it, it seems strange that such an obvious error has escaped the attention of so many thinkers and led to such disastrous results. This is not the only study, however, which has suffered from what may appear to be an unnecessary mistake !

P. R. DAMLE

Reviews

The Partnership Act, 1932, (with a commentary and explanatory notes) by S. R. Dongerkery, Esq., B.A., LL.B., Attorney-at-Law. Second Edition. pp. xxvii, 278. Popular Book Depot-Bombay, 1936. Rs. 4-4-0.

The Partnership Act, 1932, came into force on October 1, 1932. Mr. Dongerkery first published his book on the Act in the August of that year, and it was immediately hailed by the profession as a useful, accurate and lucid commentary. The reputation of the work has since then steadily increased, and despite several other commentaries by different authors, a second edition has been called for. In the case of a second edition a lengthy review is quite unnecessary. Attention will therefore be called only to a few salient features here.

To begin with, the appearance of the book is vastly improved. The get-up, the printing, the paper and the binding leave nothing to be desired. To the several useful appendices, two more have been added, one on the Bombay Partnership Rules, 1932 and another on Forms. A very useful appendix to which special attention may be drawn is Appendix V, dealing lucidly with legal proceedings by and against firms, a subject of great importance in a commercial centre like Bombay.

We admire the way in which Mr. Dongerkery, inspite of his arduous duties as Registrar of the Bombay University, keeps up his interest in law, which, to most of us, is a notoriously jealous mistress.

A. A. A. F.

The Types of Sanskrit Drama : By D. R. Mankad, M.A. with a Foreword by Dr. S. K. De. Published by the Urmi Prakasan Mandir, Denso Hall, Karachi, 1936.

Pischel's theory which traces the origin of the Sanskrit Drama to puppet show on the strength of words like Sūtradhāra and Pāñcalikā is already looked upon as obsolete. The same is the case with the theory of Windish and others who trace the Sanskrit Drama to a Greek origin. The theory which is now current traces its origin to the Dialogue hymns in the Rgveda. In the present book, however, Prof. Mankad makes a bold attempt to trace the same to Dance. He has collected a large number of passages from old Sanskrit works on Dramaturgy in the first chapter, and these

lead him to the conclusion that from the point of evolution, Nṛtta (Dance) comes first, then comes the Nṛtya (Dance Gestures) and last of all the Nāṭya (Dance Gestures Dialogue).

In chapters II to V, Prof. Mankad deals with the ten types of a Rūpaka and suggests four stages in the development of the Sanskrit Drama:—1. the earliest phase represented by a form which required only one actor and one act; 2. the second stage represented by a form which required more than one actors but only one act; 3. the third stage with many actors and more than one acts; 4. the fourth stage represented by the Nāṭakas of Bhaṣa and Kālidāsa. In chapters VI and VII, he deals with the Uparūpakas or the types of Nṛtya. Here the author has indeed taken great pains to collect material on the subject from well known ancient works and for this he richly deserves our compliments; but one nevertheless feels that in order to understand Dance and the part it played in the development of the Sanskrit Drama properly, it is equally necessary to make a careful and deep study of the different kinds of rural Dance current at present in India among the masses.

It is we believe, evident that the Dialogue hymns in the Ṛgveda represent a form of entertainment current among the cultured classes of those days. On the other hand, the root nṛt 'dance' occurring in the Ṛgveda, shows that the Dance was not unknown and perhaps it was a popular form of entertainment current among the masses. It is very probable that in course of time, perhaps towards the end of the Vedic period, the two elements i. e., Dialogue and Dance, were combined so as to attract the cultured classes as well as the masses and thus the theory which traces the origin of the Sanskrit Drama to the single element of Dance does not sound satisfactory. The suggestion made by Prof. Mankad that 'the first stage in the evolution is represented by a form which had one actor and one act is not very convincing. It is worth noting that in Ṛgveda, we meet with two types of the Dialogue hymns—those that have only one character (X. 34) and those that have more than one characters (III. 33; X. 108). Moreover, from the point of view of Art, dialogue between two or more characters looks more natural, simple and hence more primitive, than a monologue or soliloquy, in which one character alone gives vent to his feelings. Lastly, the traditional view recorded by Bharata in his Nāṭyaśāstra, ch. I, (jagrāha PĀTHYAM Ṛgvedāt Samebhyo GĪTAM eva ca; Yajurvedāt ABHINAYAM, RASĀN Ātharvaṇāt api) agrees more with the theory that traces the origin of the Sanskrit Drama to more elements than one.

Books Received

1. *Inter-statal Law—the Law affecting the relations of the Indian States with the British Crown* (Sundaram Ayyar-Krishnaswami Ayyar Lectures, 1933-34) by S. M. Panikkar (Univ. of Madras) Madras, 1935.
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*The Editor, Biological Abstracts, University of Pennsylvania, Philadelphia, U. S. A.

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